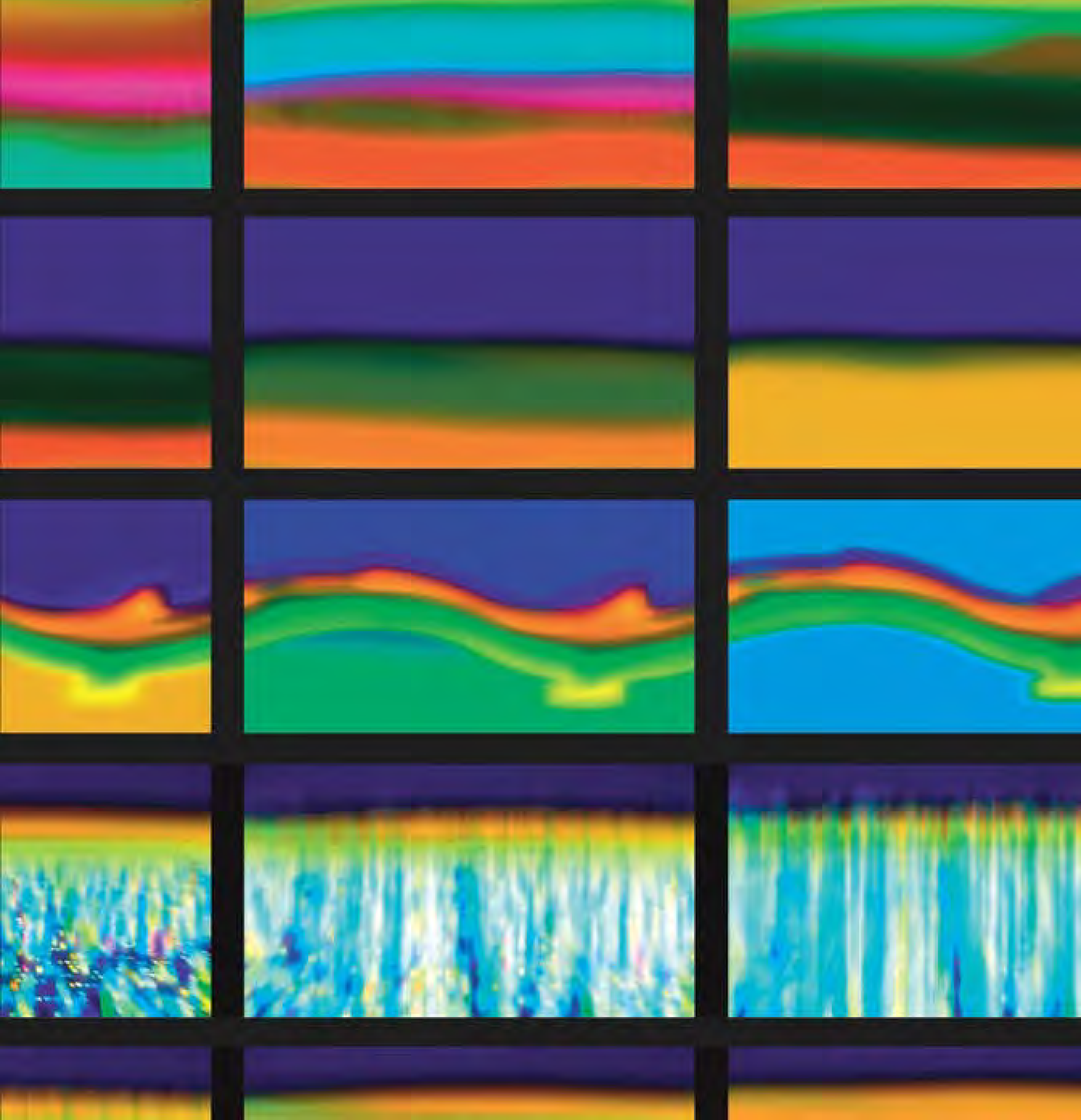
Chromatic Algorithms

Synthetic Color, Computer Art, and Aesthetics after Code

Carolyn L. Kane



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For Alex Galloway and Fred Turner

The gray rock of the industrial proletariat has been pulverized into a multicolored sand. Its colored grains form dunes, obeying the winds that blow into the scene from the outside.

—Vilém Flusser

Life is won by wresting colors from the past.

—Gilles Deleuze

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Introduction

How Color Became Code

Arriving in off-the-shelf commercial software in the early 1990s, the appearance of digital color as flexible, intuitive, and user-friendly is actually quite puzzling. There is no way for users to find out how these colors actually work or how different people see colors differently in different contexts (even the same hue fluctuates between monitors). Nor do seductive software interfaces explain that, on a technical and material level, digital color is in fact a series of algorithmic codes. While traditional color studies thrive in visual analysis, with little interest in the industrial or laboratory histories of color, the fact that digital color is a product of heightened technologization (through cybernetics, information theory, and mathematics) complicates matters because it is just as much a part of the history of computing as it is the history of aesthetics.

Chromatic Algorithms responds to this dilemma by analyzing the ways in which a few brilliant and extremely talented computer scientists and experimentally minded artists in the 1960s and 1970s managed to transform postwar computing technology and massive number-crunching machines (figure I.1) into tools used to produce some of the first computer-generated color in what they called "computer art."[1] The colors made to appear from these former death machines were so fantastic that many viewed them as revolutionary, psychedelic hues that promised a bigger and better future for humans and machines. Unfortunately, after the massive shift to personal computing, automated off-the-shelf software, the graphic user interface (GUI) in the 1980s, which readily employed icons in place of text commands, and the standardization of color in the 1990s, this experimental field closed and the wild pioneering visions dissolved.

By the end of the 1990s, however, personal computing had wedded the Internet and a different kind of utopianism filled the air. The new frontiers of cyberspace and the World Wide Web temporality reinvigorated the world of computing, transforming pixel-pushing knowledge work into a new paradigm of art and design cool. Computing, it now seemed, paved the road to yet another global village of wired e-commerce and sexy cosmopolitan connectivity. And then there was the "burst" of the dot-com bubble, after which another temporary lull befell the new media, until enthusiasm was amplified once again in the late 2000s, when sleeker hypersaturated computer colors underwent yet another (re)evolution of sorts. Through increasingly ubiquitous user-friendly interfaces and social media applications, integrated with cross-platform production techniques introduced in the late 1990s, luscious and automated electronic hypercolors came to "empower" millions of artists, designers, architects, animators, students, educators, consumers, and children to push, pull, remix, and mashup media from multiple locations and platforms, using a variety of computer, electronic, cloud, and automated PDA devices. Human-computer interaction became cool and sexy once again, and even a touch utopian, at least on the surface.

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Meanwhile, as amateurs and technophiles were remixing “authentic” 1960s cool, these automated hypercolors and stylized interfaces were further distantiated from their technical-material base, which became increasingly difficult to understand and obfuscated from end users. That is to say, sophisticated software learned to conceal its growing complexity behind a simple and transparent user-friendly façade, also known as the “Web 2.0 look,” marked by soft rounded edges and big, happy bubble letters. How did such a dramatic gap emerge between these luminous electronic colors—growing brighter, bolder, and more visible on screens and in public spaces—and their corresponding abstraction, complexity, and obfuscation in machine code? How and why did the interface become more “transparent” just as computing became more opaque? And moreover, how is this fundamental disparity between the machine code and the screen interface reflected in contemporary media art and design?

To answer these questions, *Chromatic Algorithms* places color at the center of new media studies, focusing on the role of electronic color in computer art and the development of media aesthetics after 1960. While color has always been a matter of technics (calculation, automation, and ordering systems), *Chromatic Algorithms* argues that this becomes especially pronounced in the age of digital signal processing, meriting a sustained reconsideration not only of traditional approaches to color but also of aesthetic theories rooted in hermeneutics and subjective perception. In this introduction I discuss my research methods in media archaeology and the philosophy of technology, which involve an explication of cybernetics, phenomenology, technological determinism, and technogenesis. I also introduce my main argument for a reconfiguration of color in computational aesthetics from the optic to the algorithmic paradigm, a shift marked by exceedingly high levels of automation, technical inscrutability, and stunning digital colors. I conclude the introduction with a detailed overview of the chapters in the book.

Media Archaeology

The relatively new field of media archaeology has received a lot of attention in recent years and this will no doubt continue due to its practical, historical, and critical research methods. Defined as the archival examination of the materiality of media objects, media archaeology derives from both Michel Foucault's concept of archaeology and his and Friedrich Nietzsche's concepts of genealogy: a set of relations that run horizontally—and in opposition to—official chronological histories.[2] Media archaeology favors alternative counter-narratives and leaves the markedly dominant, hegemonic accounts of History aside. Like deconstruction, the field focuses on diachrony over synchrony, events over structure, the exception over the rule, the periphery over the center, and the variable over the invariant. Accordingly, the majority of case studies I discuss concern such exceptions, failures, unacknowledged successes, and visionary experiments long forgotten.

In media archaeology, "perception" is not about looking at images, things in the world, or even about vision. Rather, it is historically mediated through a particular set of power and knowledge relations that are often invisible and unconscious. As Deleuze puts it in reference to Nietzsche's genealogical critique:

> [P]erception . . . is the expression of forces which appropriate nature . . . The history of a thing, in general, is the succession of forces which take possession of it and the co-existence of the forces which struggle for possession. The same object, the same phenomenon, changes sense depending on the force which appropriates it.[3]

If perception can be seen as the result of such successive and disparate yet historically particular tensions and forces, then so too can technology.

To accept that technology emerges from conflicting struggles and external forces, some visible and some not, is also to accept what German media theorist and pioneering media archaeologist Friedrich Kittler terms the "technological a priori."[4] The technological a priori involves a reworking of Foucault's notion of the "historical a priori," a concept that is itself a reworking of Nietzsche's critique of Kant's a priori faculties of the mind, which exist for Kant *prior to experience*. In contrast, the technological a priori and Foucault's historical a priori (qua Nietzsche), are a priori *in history*. That is, they are *existentially* constituted through specific material relations that range from but are not limited to culture, politics, aesthetics, psychology, and ideology. (And by existential I mean the way in which material conditions *retroactively* form rules, subjects, concepts, and theories, not the other way around.) The technological a priori insists that who and what we are emerges *from* a set and system of material, technological relations. In this book the historical a priori *is* the media a priori, which is to say, as Kittler infamously puts it, that "media determine our situation."[5]

I.1 The ENIAC with men and women at work, 1946. The ENIAC was the first modern computer. It contained between 18,000–19,000 vacuum tubes, more than 500 miles of wire, and weighed more than 35 tons. Courtesy of the University of Pennsylvania Archives.

My endorsement of media determinism must be taken with a grain of salt. In addition to Kittler and the above noted lineage, this thesis runs alongside the work of media philosophers including Marshal McLuhan, Vilém Flusser, John Durham Peters, Bernard Stiegler, Katherine Hayles, and Siegfried Zielinski, all of whom view media technologies as systems that resonate through and within multiple registers and produce real and tangible results not exclusive to pieces of hardware. There are several reasons why this approach is both appealing and productive in this book.

First, as Bernard Stiegler has shown through the work of Bertrand Gille, Gilbert Simondon, and André Leroi-Gourhan, technical innovation and invention *are*, to a significant degree, determined. That is, we live in a culture where demands and goals—profit, economic necessity, scientific progress, efficiency, and rationality—are *already* inscribed into industrial and post-industrial practices, production processes, and especially, Stiegler argues, in "research and development" think tanks. And, as I will argue below, all of these factors comprise a general theory of "technics." In this regard, *what* a technology is or will become is already in the works long before a physical technology appears on the scene. Technological determinism is thus founded on scientific, economic, social, and political determinants (which is also how and why media archaeology functions as a critique of so-called genius inventor and champion of history theories). Stiegler summarizes the process of technical innovation as follows: "[T]here is a reversal of meaning in the general scheme: no longer is innovation what results from invention; it is a global process aiming to incite invention, it programs the rise of invention."[6] Future technology is programmed in the past. For instance, a basic programming language installed on a mainframe computer in the 1960s already determines the limits and conditions of possible use, long *before* the computer system ever arrives at R&D centers like IBM or Xerox. The same goes for certain hierarchies and object-groups on your computer's operating system. To paraphrase Gille, in technical development, the number of usable combinations is not infinite because it always emerges from some existing base structure and must therefore follow quasi-obligatory paths. There is a "theoretical formalism" that always "precedes practical operation." In this sense, any "technology" is to an increasingly greater degree determined by other technologies and vested political and ideological interests.[7] Such frameworks form the backdrop for the innovative computer art that I discuss in the following chapters.

Second, I employ media determinism to point to common misunderstandings with the concept itself. As science and technology scholar Sally Wyatt has suggested, some proponents of technological determinism argue that "technological progress equals social change."[8] The exact opposite is the case: media technologies are material systems and environments that include unmet desires and failures with complex, intertwined and nonlinear

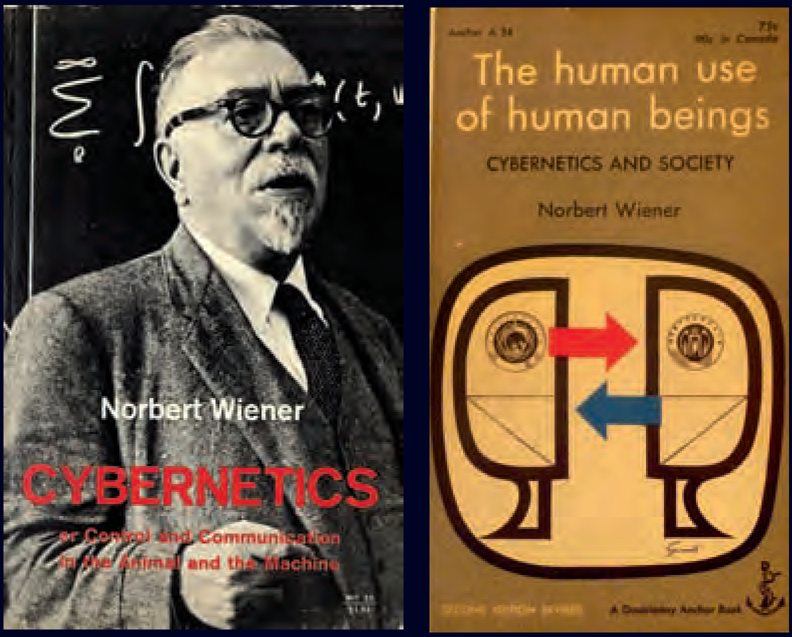
histories. To include only the attributes of innovation and development is to portray a one-sided history that supports mythologies of single geniuses and unidirectional progress. Similarly, I invoke media determinism as a provocation; to call attention to certain blind spots in new media discourses preoccupied with ever-changing media effects, content analysis, and analyses of social media and Internet applications where a single application is used to stand in for the technology as such. For example, one might use a term like "the Facebook revolution," where such a statement clings to the false assumption that "technology" can be reduced to a single application of a system; remaining blind to the ways in which technology always already intersects with the social, economic, historical, cultural, psychological, and human dimensions *long before* anything like Facebook appears.[9]

Finally, we live in an age where little if anything is experienced, produced, known, or felt that is not in some way affected by or connected to technology. Even the discovery of a "lost" tribe in Africa, Jean Baudrillard noted in 1981, has been re-mediated to us. Or, as Vilém Flusser put it in 1985, "We live in an illusionary world of technical images, and we increasingly experience, recognize, evaluate and act as a function of these images."[10] Technology—as environment and system—determines history, consciousness, and culture.[11] Such is the holistic, horizontal, and interdisciplinary logic that drives media archaeology, and it is the primary method employed in this book. In a recent guest lecture at Columbia University John Durham Peters exclaimed, "Two Cheers for Technological Determinism." I here add a third.[12] After I address the relevance of media archaeology for postwar cybernetics, I return to a discussion on the philosophy of technology.

Cybernetics

Emerging after the Second World War, the advent of cybernetics made it even more pressing to recognize the ways in which technology determines our situation. To demonstrate how links between humans, machines, and society have grown thicker, if not inextricable since 1945, it is necessary to first offer a brief history and definition of cybernetics, followed by an explanation of Heidegger's and Stiegler's philosophy of technology and the ways in which I use and misuse each scholar's work in this book.

Since 1917, mathematician Norbert Wiener (figure I.2) had been conducting military research at MIT. By the 1930s, he was studying servomechanisms in airplane bombs as a part of Vannevar Bush's military-industrial complex, or, "iron triangle" of military, industrial, and academic ties. After the war he published his seminal, *Cybernetics: Or Control and Communication in the Animal and the Machine* (1948), outlining his highly innovative approach to the new interdisciplinary field. The book was in part a response to the disastrous effects



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of the atomic bomb in Hiroshima in 1945, a development that he, like Bush, had played a significant role in. After bearing witness to these harrowing results, Wiener took an ethical turn and declared a new type of science was needed. This science was cybernetics.[13]

Cybernetics is the study of control and communication in the human, the animal, and the machine, or simply the study of the flow of information, messages, and signals between human, animal, and machine systems. Wiener developed the field when studying feedback mechanisms in steam engines—a field engineered by James Clerk Maxwell in 1865—but it was not until Wiener implemented these feedback studies with mathematician Claude Shannon's information theory, or mathematical theory of communication, that he was able to conceptualize *all systems* in terms of information.[14] That is, all communication and cultural processes could be analyzed, viewed, and understood in terms of data and pattern formation. All humans, animals, and machines were herein treated "equally": as media technologies capable of analyzing, storing, transmitting, and processing information. The new common denominator—information—was both radical and problematic.

Feedback and Information Processing

Cybernetics turns on the two principles of feedback and information processing. The term "feedback" is common in English. I may say to one of my students, "Please come to my office so I can give you some feedback

on your paper." This denotes a flow of information from the student who wrote the paper, handed it in to me, and will now receive new information about it. In cybernetics, feedback denotes a similar circular and dynamic exchange of data not restricted to linear or chronological paths. The origin of the term "cybernetics" derives from the Greek *kybernetikos* meaning to govern, steer, or guide.[15] When Wiener studied the steering mechanisms in a ship as a system of communication and control, he noted the way in which its basic capacity for feedback served as an efficient means of recycling energy and momentum within the system. Feedback increases output and introduces a degree of automation within a system. As Wiener puts it, a feedback system "tends to make the performance of the steering engine relatively independent of its load." With the correct amount of feedback, a system can become automated and learn to "guide" itself.[16]

The synthesis of feedback and information theory is also what makes cybernetics so much unlike other theories of communication. Defined as the science of quantizing data, information theory emerged from Shannon's work at AT&T (then Bell Laboratories) in telephonic communications. Information theory quantizes data in order to make communication processes more efficient. This is accomplished by separating redundancy, repetition, and as much noise as possible from an encoded signal so that it may travel swiftly and efficiently through numerous interchangeable channels. John Durham Peters explains that Shannon's information theory gave a "technical definition of signal redundancy and hence [provided] a recipe for 'shaving' frequencies in order to fit more calls on one line."[17] Because information theory quantizes data and information flows, concepts like "meaning" or "purpose," normally given great weight and significance in cultural and historical analysis, are abstracted and transformed into statistically calculable "units of measure." Katherine Hayles has argued that information herein "lost its body."[18] Or, as Shannon put it in 1949, information "must not be confused with meaning . . . In fact, two messages, one of which is heavily loaded with meaning and the other of which is pure nonsense, can be exactly equivalent."[19] In information theory, the system only knows what it parses, processes, and orders as information, all else is "noise."[20]

The radicality of the integration of cybernetics with information theory was the abstraction of communication but also, precisely by virtue of this abstraction and quantification, a new and unforeseen potential for messages to travel through universal channels and nonparticular circuits. Before cybernetics, machines were understood in terms of hard mechanics and singular system functions, but afterward, machine systems became flexible, nonlinear, dynamic, and malleable. Information was no longer simply "raw data, military logistics, or phone numbers," Peters writes, but instead the newfound flux and flow of the cosmos; the new "principle of the universe's intelligibility."[21]

I.2 Book covers for Norbert Wiener's *Cybernetics: Or Control and Communication in the Animal and the Machine* (2nd edition, MIT, 1965) and *The Human Use of Human Beings* (2nd edition, Doubleday/Anchor, 1954). These texts were foundational in the science of cybernetics, information theory, and disparate branches of media theory and practice.

The Macy Conferences

At the Macy Conferences, a set of conferences initiated by Warren McCulloch and held at the Josiah Macy, Jr. Foundation in New York from 1946 through 1953, cybernetics moved beyond the confines of engineering and mathematics. The meetings brought together researchers from such disparate fields as psychology, science, mathematics, anthropology, information theory, engineering, and cognitive science. One of the primary goals of the conference was to build and develop a "science of the workings of the human mind" by bringing machine metaphors, logic, and functions into an analysis of the human. The meetings marked the beginning of interdisciplinary work and research in the arts and sciences and the ongoing efforts to move across disciplinary boundaries. Cybernetics has since become a relatively under-acknowledged model central to analyzing multiple aspects of cultural life including economics, game theory, financial markets, ecological movements and systems, aesthetic theories and practices, business management styles, and the construction of interior and exterior spaces, all of which are increasingly reliant on optimization-seeking algorithms and information systems. One reason cybernetics remains unremarked yet prevalent in so many of these applications is precisely because it is so integral and pervasive. Of all of these uses, however, the one that is most apropos to this book is the way in which cybernetics was appropriated in computer art and new theories of the subject in the late 1960s.

Cybernetic Subjectivity, or, the Posthuman

Looking back on its first few decades, in 1999 Katherine Hayles argued that cybernetics led to a fundamental shift in human ontology marked by a move *away* from the liberal humanist subject into what she terms the posthuman. The liberal humanist subject, according to Hayles, is rooted in C. B. Macpherson's analysis of the possessive Western individual who is essentially "the proprietor of his own person or capacities, *owing nothing to society for them.*" According to Macpherson, "human essence is freedom from the wills of others, and freedom is a function of possession," which is to say, the myth of the private, proprietary self.[22] Such a view was challenged in cybernetics, alongside theories of the autonomous subject introduced to philosophy from Descartes through Kant, which I return to below.

But to be clear: the posthuman does not mean the end of the human or that the human is now a computer. Instead, the posthuman denotes the end of the isolated and private subject, and thus, the end of individual autonomy and domination over other forms, whether mechanical, electronic, or otherwise.[23] Posthumanism reaffirms the crossovers fundamental to cybernetics: humans can be understood through metaphors of computation, while computers and

animals may be analyzed through an anthropocentric or humanistic lens.[24] At the dawn of the twenty-first century we—"we" being people who encounter technology on a daily basis—willingly accept that "feedback loops between culture and computation create a co-evolutionary dynamics in which computational media and humans mutually modify, influence, and help to constitute one another."[25] In and through our technology we create and sustain the posthuman. Technology determines our situation and what this technology is, was, or will be is equally contingent on use, choice, and innovation (which is, as I have already noted, predicated on broader systems of technics, politics, and historical narratives). We are all cybernetic beings to the extent that we are already a part of larger systems and processes, what Neil Postman called a "media ecology" in 1968,[26] what Hayles in 2010 described as "datasets within broader computational environments," and what Bernard Stiegler theorized as "technogenesis" in 1994.[27] "If we humans are simply parts of systems," Noah Wardrip-Fruin writes, "our skins are not boundaries but permeable membranes, our actions measured as behavior rather than by introspection—the autonomous, sufficient 'self' begins to seem an illusion."[28] In chapters 5 and 6 I will return to these theses in my analyses of "hyperdividuation" and the "algorithmic lifeworld," respectively.

Cybernetics then is not just about computers. It is also a historical and cultural phenomenon that signifies nothing short of a paradigm shift eroding deep seeded liberal humanist ideas of subjectivity.[29] In the age of cybernetics and networked everything, posthumanism can no longer be denied or ignored. But what would Western history have been like if we had always conceived of life and machines in this symbiotic fashion? What if we had always exalted and praised technology, automation, and synthetic prosthetics as equal, if not superior or prior to the "authentic" and spiritually drenched human? Technics, as Mark Hansen put it in 2010, is not something external or contingent, but rather, "*the* essential dimension of the human."[30] This is precisely the direction I want to go in the next few sections, to argue that human-technical systems are not only fundamental to Western culture in the wake of postwar cybernetics but also that *algorithms and mathematics have, from the start, been inextricably bound to what it means to be human.* To unpack this—and to do so as a primer for the chapters that follow—I detour through classical phenomenology and the philosophy of technology, as offered by Martin Heidegger and Bernard Stiegler.

Phenomenology's Critique of Technics

Counterbalancing media archaeology, phenomenology also informs my theoretical methods. Defined as an investigation of being and appearing in the world, phenomenology is committed to finding new models of human

experience, perception, and freedom that resist rational and normative conventions. Pioneering phenomenologist Edmund Husserl introduced the notion of the transcendental bracketing of subjective "intentionality," or "eidetic reduction" (*epoché*), to access what he termed the "lifeworld" (*Lebenswelt*). The lifeworld is an interrelated and immediate universe of "givenness"; a "presence in the world" that appears to transcendental consciousness when one is aligned with others: "in living together, [we] have the world pre-given in this together . . . the world as world for all."[31]

Broadly speaking, Heidegger's phenomenology follows from Husserl's but also strongly veers from it. For Heidegger authentic being in the world is revealed through the figure of Dasein, literally meaning there-being (*da-sein*), defined as the "entity which we are ourselves."[32] However, Dasein exists most authentically in the disorientation of being in time, not in the immediacy of an atemporal transcendental reduction.[33] As with cybernetics (though Heidegger would *very much* dislike this superficial comparison), Dasein's "subjectivity" runs orthogonal to Western notions of subjectivity that begin with classical metaphysics, namely with Plato and Aristotle. In classical theories of the subject, being is interpreted as an "ontic" substance-thing, divorced and separate from the world. When being and the world are reified, metaphysics is born. This split is ultimately a false one for Heidegger, but one that nonetheless builds momentum throughout the Enlightenment and in modern science, through Descartes' *cogito*—"I think therefore I am"—and Immanuel Kant's theory of the autonomous and self-legislating subject in particular.[34] For Heidegger, originary and authentic being in the world are co-productive and dynamic systems of exchange between past and future; being and world; and therefore world as being.

Similarly, for phenomenologist Maurice Merleau-Ponty it is only through qualitative and embodied sensory consciousness that existence known. In his 1945 *Phenomenology of Perception* he writes: "There is no inner man, man is in the world, and only in the world does he know himself."[35] Being is "always already" a question of embodied perception in the world because being begins on *the material ground of anonymous and depersonalized sensation*. Again, the "facticity" of matter (*hyle*) is privileged over theoretical abstraction. Identity emerges a posteriori, *after* the world moves through being, not the other way around. In this way, for both Heidegger and Merleau-Ponty phenomenology is a form of existentialism.

For Husserl, Heidegger, and Merleau-Ponty alike, phenomenology thrives in the lifeworld, an alternative to what they perceive to be the objectifying and reifying practices of mathematics (*mathesis*), science, and technology. For Husserl the advent of calculation and the technization of mathematical thought, which he traces back through Galileo, marks a turning point after which all Western knowledge goes "down a path that leads to a forgetting of its

origin," which is to say "being in the world."[36] To a large degree, phenomenology exists as a critique of the rational and quantified methods of calculation, intrinsic to technics, and in this regard it is the *absolute antithesis to cybernetics*. In his unfinished critique of the European sciences, cited above, Husserl writes, in "calculation, one lets . . . signification recede into the background as a matter of course, indeed drops it altogether; one calculates, remembering only at the end that the numbers signify magnitudes."[37] Because arithmetic math consists of abstraction, it is without contextualization or "world" as Heidegger would put it. Without the context of a nuanced lifeworld, the results of mathematics or calculating methods hold little value for these philosophers. In sum, precisely what counts *as* information in cybernetics is that which is renounced in phenomenology. And thus, despite superficial similarities in "systems approaches" to being, cybernetics and classical phenomenology could not be more different: the former is pure *techné*, the latter pure *poiesis*.

Where the classic phenomenologists argue that an essentially ahistorical bracketing (Husserl) of authentic human experience (Heidegger) and pure subject perception (Merleau-Ponty) is possible, in *Chromatic Algorithms*, I update these arguments to the present to argue that *human and machine perceptions are inextricably fused* in what I term an "*algorithmic lifeworld*," where science and technology are integral to all forms of knowledge, perception, and experience.[38] Media and technology do not merely determine our situation; they are constitutive of it *and* of what it means to be human. Therefore, while I borrow from classical phenomenology, I in no way refute science or math, yet I do remain critical of them, just as I remain critical of art and aesthetics.

Heidegger's Philosophy of Technology[39]

Heidegger's philosophy of technology is largely concerned with an analysis of the pre-Socratic relationship between *techné* and *physis* (originally *phusis*).[40] *Techné* denotes technology as practice: it is the "name not only for the activities and skills of the craftsman, but also for the arts of the mind and the fine arts." *Physis* is translated as nature, denoting for Heidegger a special process of revealing and concealing from within itself, where *physis* is "the arising of something from out of itself, it is a bringing-forth a *poiesis*. *Physis* is indeed *poiesis* in the highest sense."[41] A tree emerging from a seed would be a perfect example. But more significantly, he continues, "*Techné* belongs to bringing-forth, to *poiesis*; it is something poetic."[42] In its original sense then, *techné*, like *physis* and *poiesis*, involve a fundamental—*essential*—revealing that gathers all of the four causes (the material, formal, final, and efficient) into itself, in the process of bringing itself forth from within itself as kind of self-presencing of being in time.[43] These are, and this is significant, *pre*metaphysical definitions of

the terms, which is to say, *before* Plato; when *techné* was organically and authentically bound to *poiesis* and *physis* in the lifeworld.

Moreover, Heidegger shows that *techné* in its origin is linked not only with *physis*, but also to knowledge: "From the earliest times until Plato the word *techné* is linked with the word *episteme*. Both words are names for knowing in the widest sense. They mean to be entirely at home in something, to understand and be expert in it. Such knowing provides an opening up."[44] Once being, building, thinking, and world are forced apart and theorized as separate, non-coextensive entities, however, these holistic links are broken. What we have in this picture is typical of Heidegger's romantic thinking: an originary Greek world wholly and organically unified, mysterious, totally authentic, and long forgotten in a broken and degraded modernity. What happened?

When Plato and Aristotle came along, they introduced the beginning of the end of being, or simply metaphysics, though ultimately the real culprits for Heidegger are Descartes and Kant. Henceforth new goals and desires came into play, appetites to "master" the world and "set it in place," whether through abstract, theoretical knowledge (Plato's mathematical Forms), scientific analysis and classification, technical prosthetics, or the metaphysics of being, which, as noted above, phenomenology exists in response to. Throughout the Renaissance and Enlightenment, these metaphysical impulses and ordering systems intensified, and *techné* was divorced from *poiesis* for good. Any modern science, Heidegger explains, could be conducted only within the bounds and parameters of what that science *already* set in place:

> Modern science's way of *re*presenting pursues and entraps nature as a calculable coherence of forces. Modern physics is not truly experimental because it *applies* [an] apparatus to the question of nature.

The theoretical methods of calculation, as employed by physics, can only know what it has *previously* determined to exist.[45] Physics can only ever "observe nature (*physis*) insofar as nature exhibits itself as inanimate," which is to say, dead and reified because abstracted and separated from the (life)world in advance.

Modern science is of course directly linked to modern technology (what Stiegler refers to as "technoscience"), which has also been so dramatically removed from *poiesis*, for Heidegger, that it has become instead a kind of perversion of itself, characterized by a "challenging forth" of the earth, forcing nature out of itself, making our (human) relationship to authentic and mysterious being that much more inscrutable and opaque.[46] Modern technics "does not unfold into a bringing-forth in the sense of *poiesis*," Heidegger writes, "The revealing that rules in modern technics is a challenging, which puts to nature the unreasonable demand that it supply energy which can be extracted and stored as such."[47] The challenging forth of nature by modern technology occurs within

a complex and obfuscated edifice that Heidegger terms “enframing” (*Gestell*), which, in the wake of cybernetics, arrives at a dangerous point of completion.

Gestell is a useful term because it involves multiple valencies. First, it denotes a literal setting, framing, or putting in place (*stellen*); a kind of ordering and arranging that becomes progressively forceful. A windmill on the Rhine River for example is structured to allow air to be gathered and transformed to generate energy. This is a fairly benevolent setup. In contrast, a power plant on the Rhine “unlocks” energy from the earth, transforms it, and stores it in a “standing reserve.” Unlike the windmill, the power plant aggressively orders and “enframes” the earth, treating it as a resource to mine from, not as a part of an already (divinely) ordered world with its own mode of revealing (*physis*).[48] Because the power plant does not work *with* or *for* the world but instead against it, its enframing is more severe as it locks and conceals earth from world. For Heidegger then, as it is for media archaeology, “technology” is never a single tool or object, but rather, a *system and context of innovation, application, awareness, and use* that is more often than not regulated and controlled by external and often invisible forces. This is precisely what Heidegger means when he declares the “essence of technology is by no means anything technological.”[49]

The Algorithmic Lifeworld

There is a significant problem with Heidegger’s philosophy of technology, one that may be leveraged against classical phenomenology in general. This is an obsession with authenticity. For Heidegger, the authentic human, the mysteries of nature (*physis*) are privileged over the artificial and the synthetic. I propose instead a counterdiscourse that proactively uses the marginalized terms—the synthetic and artificial—as a means of reframing and reconceptualizing our relation to technology and its history. To be clear: this is not a negation but a reconfiguration that honors both terms. “At its very origin and up until now,” Stiegler writes, “philosophy has repressed technics as an object of thought. Technics is the unthought.”[50] What then if technics were thought, not only as a part of being, but as its genesis; intrinsic to the very notion of the human? Suppose that technics is and has always been at the center of what it means to be human, and thus *of* thought and *how* we think?

Stiegler demonstrates this thesis throughout the volumes of *Technics and Time*. He proposes the notion of technical evolution, or “technogenesis,” implying that humans and technics have coevolved together over time. Moreover, “techno-genesis is structurally prior to socio-genesis,” as he puts it, because “humanity’s history is that of technics as a process of exteriorization in which technical evolution is dominated by tendencies that societies must perpetually negotiate.”[51] He draws evidence for this by tracing the link between *techné* and *phusis* back through the Greeks to show how the origin of technics

is embedded in the origin of mortality, or thanatology, given that life always anticipates death (finitude), and thus factical being—the precondition for being-in-the-world in Heidegger's existential analytic—*is at root a form of calculation* (*mathesis*). In this way, Dasein's fundamental facticity merely reinforces the way in which any phenomenology of being is first and foremost grounded in *calculation*, which is to say, a form of technics. Stiegler writes:

> The technical world, the technicity of the world is what reveals the world "firstly" and most frequently in its facticity. Facticity, understood as what makes possible the attempt to determine the indeterminate . . . forms the existential root of calculation. Calculation, the existential rooting of which is organized by facticity as an essential trait of technics.[52]

If "technicity" is "what reveals the world 'firstly' and most frequently," then the distinction between being as originary and technology as a secondary prosthetic or derivative is a "false one." As he writes in Volume 1, "[I]f the technicization of knowledge remains at the heart of the Heideggerian reflection on the history of being, *ratio* appears, in its essence, to be given over to calculation; *ratio* is a technical process that constitutes the *Gestell* (*ar-raisonnement*) of all beings."[53] Authentic Dasein is always already technical and synthetic. It is "calculation," Stiegler argues, that "makes heritage possible, constituting from the start, the originary horizon of all authentic temporalization."[54] By exteriorizing and ordering ourselves in and through our tools, artifacts, and various forms of technical memory, we always have a relation to calculation and thus to technology that is not merely "external or contingent," i.e., based on difference, but rather *essential and intrinsic*. Because the postcybernetic era is overwhelmingly governed by the logic of automation, optimization, and informatic reduction, what results is a generally inscrutable and opaque lifeworld. I will expand on this in chapter 6, though it is crucial to observe here that I do not analyze algorithms from a technical or business perspective but rather as an umbrella philosophical concept to denote this emergent ontology.

In a sense, Stiegler's elaborate theory of technics is akin to what Friedrich Kittler was getting at with his notion of the "technological a priori," though the latter puts a more provocative spin to it. "Unlike Marshal McLuhan," Eva Horn writes, "who saw technical media 'as extensions of man,' Kittler saw . . . *man as an extension of media*."[55] So too it is for Stiegler. Who we will become is determined through the technology we use and create today. Therefore, while Stiegler's philosophy of technology has a markedly phenomenological bent, it is in some ways sympathetic to Friedrich Kittler's in that both employ anti-anthropocentric lenses to the history and philosophy of technology and both argue that technics and technology are temporally prior to the human, and therefore, to any form of "humanism."[56]

Finally, technogenesis, very much *like* media archaeology, is unconcerned with "progress" narratives. As Katherine Hayles argues, Stiegler's concept of technogenesis lends itself to theories of "epigenetic" evolution, which posit that changes in human thought and experience are "initiated and transmitted through the environment rather than through genetic code." She writes:

> [Technogenesis] offers no guarantees that the dynamic transformations taking place between humans and technics are moving in a positive direction. Rather, contemporary technogenesis is about adaptation, the fit between organisms and their environment, recognizing that both sides of the engagement (humans and technologies) are undergoing coordinated transformation.[57]

Life as technics, which is also to say mathematics, means that experience and "consciousness," to use Stiegler's terminology, are inscribed and programmed in and through our technical systems. And while this has always been the case, these inscriptions and encodings, as I argue above, have been amplified and exacerbated in the age of the algorithm, where advanced cybernetics, information-intensive modes of production and consumption, and automated hypertechnical realities have become impossible to deny or ignore.

To claim that humans and machines are inextricably fused in a technological lifeworld, one that currently privileges the algorithm, is merely to update the claims of theorists like Marshall McLuhan, Norbert Wiener, and Gregory Bateson, who argued in the 1960s for the dawn of a new cybernetic cosmos and media ecology; what Gilbert Simondon, Bertrand Gille, and André Leroi-Gourhan described as technical systems; or what Buckminster Fuller, Harold Innis, and Lewis Mumford argued for communications and the built environment a generation prior. These attitudes have come back into intellectual fashion, primarily through the pioneering work of media archaeologists like Kittler, Zielinski, and Flusser, and more recently in the work of Bernard Stiegler, Katherine Hayles, Erkki Huhtamo, and Jussi Parikka among others. When I return to the notion that the algorithm has become a primary actor in our social, political, and cultural landscapes in chapter 6, I also address how new forms of experience and desire are engendered in this algorithmic lifeworld.

In sum, our so-called tools are partly psychic and partly social, but always historical. Any technology or ordering system may be used to deny and cover over these connections or to reveal the inextricable links and relations between them. To show that this is a choice, and one that remains solvent in algorithmic culture, is to argue for the persistence of and ongoing capacity for critical thought. In this book my theoretical methods, outlined above, draw primarily from media archaeology and a technologically infused phenomenology. I also use interpretative analysis of artworks, textual analysis of archival materials, primary and secondary sources in the history of color studies, aesthetics, and computing, and interviews and correspondences with key scientists and artists

involved in these histories. Together these methods allow me to demonstrate how electronic color experiments have contributed to a reconfiguration of media aesthetics after 1960.

Book Overview and Chapter Breakdown

The chapters unfold in a general chronological order, moving from a set of historical chapters in parts 1 and 2, to a set of stylistic ones in part 3. My goal is to use electronic color to chart the material-historical development of computational aesthetics after 1960. As periodization arguments go, dates and styles may overlap, occur out of order and in a nonchronological fashion. For instance, Andy Warhol's cold use of Day-Glo color in the mid-1960s, noted in chapter 1, or the hyperrational information aesthetics developed by Max Bense in Germany in the 1960s (discussed in chapter 3), stylistically fits more with the cool, tongue-in-cheek color sensibilities of new media art and design circa 2009 than with the otherwise predominantly mystical and cosmological approach to color in U.S. computer art circa 1969. Alternatively, chapter 5 ends with a discussion of dirt style net art in the 2000s, while chapter 6 discusses infrared artwork from the 1970s and the 2000s. So despite the book's basic chronological organization, the history of electronic color in digital computing and the development of contemporary media aesthetics after 1960 has been anything but a straightforward, linear process. Nonetheless, I here provide a chronological overview of the book.

Part 1 begins with chapter 1, which operates as a second introduction by providing a context to understand color and its role in Western aesthetics and philosophy from Plato through the psychedelic 1960s. Because there is no extensive history of color in new media art to date, save for this book, the two introductions are necessary as primers for the chapters that follow, which analyze electronic color and aesthetic computing together. Also, as a precursor to my analysis of *electronic* color in chapters 2 through 7, chapter 1 offers an archaeology of *chemical*-based synthetic fluorescent colors from the nineteenth century through their popularity as Day-Glo in postwar America.

Chapter 2 enters the New Television Workshop at Boston's WGBH television studios circa 1969, where, under the guidance of visionary director Fred Barzyk, pioneering video artist Nam June Paik and Japanese engineer Shuya Abe created one of the first video synthesizers capable of generating electronic color for visual art. In this chapter I also analyze the unique projects in televisual color and video synthesis developed by Eric Siegel and Stephen Beck, connecting them to theories of technological transcendence then prevalent in experimental media art discourses and in Heidegger's earlier notion of existential transcendence, which I read through Graham Harman's more recent, though nonetheless contested, interpretation. As the first of the joint

color-computation chapters, chapter 2 analyzes color in *analog* computing systems that are likely foreign to most readers, especially those "born digital." Readers will be surprised to discover the sheer amount of time, labor, and technical knowledge required to use these early computers to create visual art. And while I delineate the specifics of the technical equipment used, this is primarily done to *complement* and *enhance* my aesthetic analyses, emphasizing how much more remarkable it is that, after hurdling such obstacles, an ethos of mysticism and technological transcendence nonetheless accrued to this work. Moreover, and this applies to the whole book, I occasionally use technical terms, technical references, minor technical descriptions, and allude to the broader history of postwar computing and experimental media art but for the most part I do not analyze these references or alternative technical narratives to any substantial degree. For those readers familiar with the industrial, technical, economic, or business histories of computing and algorithms, or alternatively, the history of the avant-garde, these references will provide an added layer.

In part 2 (chapters 3, 4, and 5), I focus on key creative and experimental uses of color in the 1960s and 1970s, highlighting how (mostly) American scientists, computer programmers, and artists developed new techniques to bring color into computer art before the now standardized, ubiquitous, and user-friendly GUI and digital color palette.[58] To delineate the parameters of what I identify as a "U.S. style" of early computer art, chapter 3 offers a comparative analysis of color in early computer art in the European (though mostly German and Dutch) and U.S. contexts. The chapter shows how the former approach maintained a highly rational attitude towards color (in a pursuit of "Programming the Beautiful") while the U.S. school tended towards mystical, utopian, and spiritual uses of color, as noted above. Specifically, I analyze the innovative use of color in the pioneering work of European computer artists and aesthetic theorists including Frieder Nake, Max Bense, Peter Struycken, and Herbert Franke, which I then compare and contrast to the work of U.S.-based John Whitney Sr., Stan VanDerBeek, and Ben Laposky. Counterexamples are given in the chapter though my characterization of the U.S. school in chapter 3 is reinforced throughout the book, and especially in chapters 2 and 4.

In chapter 4 I turn to the aesthetic and cultural-historical analyses of color and early computer art in the exclusive context of the U.S. in the 1960s and 1970s, focusing on key computer artworks developed by A. Michael Noll, Kenneth Knowlton, Leon Harmon, Béla Julesz, Max Mathews, Joan Miller, Laurie Spiegel, and Lillian Schwartz all of whom worked at or were associated with Bell Laboratories during this time. I also analyze Richard Shoup's "SuperPaint," a pioneering color paint system he developed at Xerox PARC in the early 1970s.

In the first half of chapter 5, I conclude the book's historical analysis with an account of key color experiments produced at NYIT, Xerox PARC, and WGBH in the early 1970s and 1980s. I focus on Alvy Ray Smith and Ed Catmul's

development of the “alpha channel” and Peter Campus’s pioneering contributions to chromakey compositing, which, I argue, mark the advent of a new “spatial” aesthetic in electronic imaging. The second half of chapter 5 turns to the “surface layer” or rather the interface and screen, where I analyze trends in net art and digital media design in the 2000s (using the work of Paper Rad), characterized by a low-fi dirt style, and cool “aesthetic of interference,” as Kittler informally coins it. Chapter 5 is located in part 2 because the majority of the chapter consists of historical material. However, the chapter’s concluding discussion of dirt style and the 2.0 look, both of which became popular only *after* automated color and streamlined digital compositing, offers a segue way into part 3.

This shift to automated color marks an important turning point in the book, indicative of the ways in which the experimental field in aesthetic computing closed in the 1980s, after the advent of mass-produced personal computers, the development of the GUI, the standardization and automation of software, hardware, and Internet protocols, and the increased commercial and industrial control over all aspects of computing. As a result, in the late 1990s, digital color in the new school of art and design cool became an issue of style and media critique and much less about the capacity to “transcend” technology, express some inner vision, or alternative reality, as much of the art of the 1960s did.[59] Another reason for this shift, and I will provide several throughout the book, is that in contrast to those who produced computer art in the 1960s and early 1970s, computer artists and designers after the late 1990s had little need to learn programming or understand how to write a computer program and thus “computer art” simply became “art and design” or “new media art” at best.

The new paradigm of digital colorism, previewed at the end of chapter 5, is the subject of part 3, which includes chapters 6 and 7. In chapter 6, the now functional and highly automated digital color is reframed as cold, algorithmic color. I argue here that the algorithm has become culturally dominant in terms of both visual imaging practices and ontology, heralding what I refer to as the “algorithmic lifeworld,” illustrated through infrared visualization and low-resolution “cam-girl” exhibitionism. The algorithmic lifeworld presents both an extension of and a challenge to classical models of vision rooted in optics, the hegemony of the (human) eye, and theories of the gaze. In contrast to an optical image like a photograph or film, an algorithmic image is a *system* operating through the post-optic principles of informatic reduction, predictive scanning, and the allegorical presentation of data. At the core of these processes is the algorithm, a well-defined set of steps one must undertake in order to execute an operation. Algorithms are rarely singular though they are always mathematical, statistical, and nonspontaneous. I use digital infrared as my primary example of algorithmic images, which I analyze in the work of new media artist Jordan

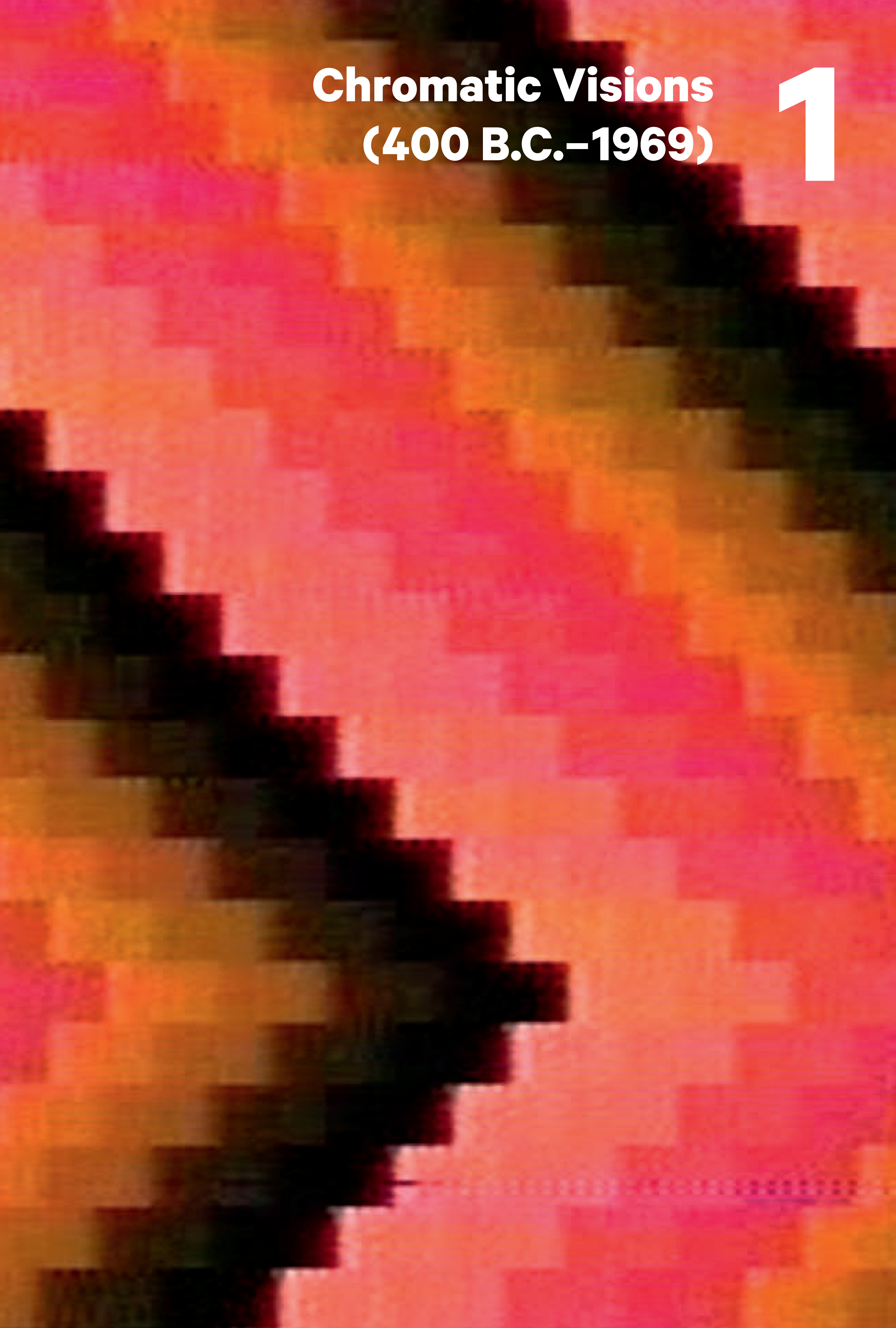
Crandall, the Graffiti Research Lab (G.R.L.), Experiments in Art and Technology, Denis Oppenheim, and a selection of infrared scenes in military action films made after 1987. Through these examples I illustrate how the new algorithmic paradigm on the one hand engenders a cultural imaginary rooted in fear and anxiety surrounding new modes of post-optic, algorithmic perception, and on the other hand, a new ontology of exhibitionism where one shows in order to become—to exist—in the information-intensive lifeworld.

Where chapter 6 charts an end game for visual epistemology (which I term "post-optics"), chapter 7 follows suit by analyzing an emerging style of visual media equally unconcerned with nuance, detail, or optical clarity. Here, cool and luminous hazy images appear in what I term the "Photoshop cinema," analyzed through the work of American artist Jeremy Blake and a selection of recent feature films that employ color grading techniques in the form of thick patches of digital color that, I argue, function as a stylistic and conceptual opacity in the image. In the twenty-first century, digital color no longer invokes the utopic and mystical visions that it once did in the 1960s, but rather the logic of the algorithm and realities of the information age, marked by blockage, absence, inscrutability, and automated indifference.

In the postscript I bring chapter 1's archaeology of fluorescent colors into the twenty-first century with an analysis of fluorescents in transgenics, bio-engineering, and bio art. Under the heading of a "New Dark Age," a term I borrow from the title of Ben Jones's 2009 solo exhibition at Deitch Projects in New York City, I braid together several of the book's thematic threads, providing an overview of the shift from the visionary and utopic 1960s to the new dark age that is, paradoxically, filled with brighter and more saturated hypercolors, generated by increasingly stealthy algorithms. To have "color consciousness" today means looking beyond the often gauche and hysterical colors on a homepage, Internet advertisement, or web profile. Looking past the brightness and so-called high visibility of our chromatic screens allows us to understand how color connects to complex experimental, aesthetic, cultural, and technical-material histories. At the same time, to say that color has become algorithmic is also to say that color has escaped and circumvented it. To grasp this paradox is first to understand color and second to understand the ways in which it has played a pivotal yet unacknowledged role in the material development of contemporary aesthetics and the history of new media art.

1

Chromatic Visions (400 B.C.–1969)



Chapter One

Colors Sacred and Synthetic

We live in an age of chromophobia, argues anthropologist Michael Taussig, carrying the values and traditions of a "dark Europe" where, as Goethe once suggested, "people of refinement avoid vivid colours in their dress, the objects that are about them, and seem inclined to banish them altogether from their presence."[1] When Europeans import bright and bold dyes from southern, "primitive" countries, they subtly integrate them back into their "more refined" tastes. Only "uncivilized nations, uneducated people, and children," Goethe wrote in 1810, "have a great fondness for colours in their utmost brightness."[2]

Perhaps Taussig and Goethe are in part correct. Many "first world" citizens work and play in black, white, and grey, punctuated by the occasional pink work shirt, red tie, or fashionable purple scarf. A splash of vibrant color is tolerated, so as long as one keeps it under control. The same set of generally unspoken rules apply to workspaces, domestic interiors, "tasteful" material objects, and especially to Modern art, the quintessential unleashing of bold colors within a sturdy and unwavering rectangular frame. And yet one wonders, in an age of ubiquitous electronic computing and global communications, do these old world values still apply? Does the imperialistic and colonial history of chromophobia continue to thrive on one's desktop, television, or cell phone screen?

Chromatic Algorithms argues that they do not: since the 1960s the United States has embraced a new world of electronic, synthetic color. Decked from head to toe in electronic hues and digital screens, the cultural landscape abounds with color film, television, fluorescents, op art, billboards, Internet banner ads, screaming neon signs, dazzling fashion displays, postmodern architecture, luminous screen savers, and brightly colored multiscreen installations in pharmacies, shopping malls, airports, airplanes, gyms, and cars. The ongoing and accelerated struggle for consumer attention is increasingly played out through color media, further amplified by the ever-increasing size and scale of global urban centers. Chromophobia may have been valid in Western Europe during the nineteenth and early twentieth centuries, but today—at least in terms of the media environment—it is obsolete.[3] How then can one account for this turn of events and explain how the longstanding tradition of chromophobia came to reverse itself in such a short period of time?

These questions are difficult to answer because color is not only difficult to see, it is even more challenging to analyze. And yet without it the world would look dim and incomplete. In 1963, Bauhaus colorist Josef Albers explained that "in visual perception a color is almost never seen as it really is—as it physically is. This fact makes color the most relative medium in art."[4] Given that color behaves on its own terms, irrespective of the codes, protocols, and ordering systems that attempt to discipline and contain it, how then should one approach it? Histories of color, such as this one, must chart the failures and successes of a new color technology while also explaining what color is and how one produces it. In this chapter, I provide a historical background and

context to understand color, first by describing some of the major color conundrums and paradoxes in the history of Western art, science, and philosophy and second by providing an archaeology of Day-Glo fluorescents, chemical colors that explode into high visibility at the end of the 1960s. The chapter serves as a second introduction to the book. Where the first introduction provided an overview of my themes and methods, this introduction provides an overview of color and its role in Western philosophy and aesthetics from Plato through the psychedelic 1960s. Both serve as primers to understand the emergence of luminous electronic color in the chapters that follow.

I. Classical and Modern Color: Plato through Goethe

The ancient and eternal question "what is color?" has not yet been fully answered. A preliminary set of problems arises from the fact that each individual, and group of individuals, sees color differently. Several people may be exposed to the same object—a computer screen, a can of Coke, a translucent earthworm—from the same vantage point and under the same viewing conditions, and yet each will see the object in a unique way. This is because a person's physiology, history, culture, and memory structure his or her visual perception.

Visual responses to color also diversify across language, gender, and ethnic divides. While only 0.5 percent of Caucasian women are red-green colorblind, up to 8 percent of Caucasian men are. (Recall gender stereotypes of women and gay men knowing how to coordinate colors better than heterosexual men.)[5] Memory alone betrays color. After exposure to a bright red dress, when one later attempts to recall it in the mind, it is usually remembered in a hue darker than it actually is. Language and nomenclature both alleviate and exacerbate color problems. Ludwig Wittgenstein argues that the English phrase "red-green" denotes a fundamentally insecure relationship between color and language by invoking a color reality that could not possibly exist.[6] Color is an elusive "language game" where one assumes a color consistently denotes a hue like "grey-green," but what this term actually means is "indeterminate and relative to specific contexts and situations." For Wittgenstein ephemerality and indeterminacy lie at the heart of any color's claims to sameness.[7] As Albers put it:

> If one says "Red" (the name of a color) and there are 50 people listening, it can be expected that there will be 50 reds in their minds. And one can be sure that all these reds will be very different . . . When we consider further associations and reactions which are experienced in connection with the color and the name, probably everyone will diverge again in many different directions.[8]

And yet naming colors is one of the few methods humans have for arriving at any sort of agreement as to what a certain color is. Moreover, while

humans are in theory capable of seeing innumerable colors, on average, an English-speaking culture can only recognize and name about thirty different colors. While designers, color physicists, and artists train themselves to see and name more colors, these specialists are far from the majority. Seeing color is a matter of cultural and historical training.

In Western psychology, symbolic systems have been developed to decode the mysteries of color. These techniques tend to equate a color—usually one of Newton's primary spectral colors: red, orange, yellow, green, blue, purple, or violet—with a number; a musical note (first attempted by Pythagoras); or a gestalt or mood, such as Charles Fère's experimental treatment of hysterics with colored lights in the 1880s under the banner of chromotherapy. The well-known color consultant Faber Birren further developed such psychologies of color in his *Color Psychology and Color Therapy* (1950), *Color Perception in Art: Beyond the Eye into the Brain* (1976), and *Color and Human Response* (1978). These techniques, however, tend to designate a hue, such as red, as representative of a mood like anger or rage, or a note like F sharp, but, as noted, such a correlation is culturally coded and what red means in one culture may signify the opposite in another culture. For example, in China, white—not black—symbolizes death and mourning.[9] Or consider the symbolic value of a Western man wearing a pink suit to the office. Today this might signify fashion and style, as it may have in the 1920s, but in the 1950s, it may have suggested something quite different. While these symbolic and indexical approaches to color can fascinate color knowledge, this chapter does not, nor does this book, employ them at length.

Instead, as I note in the introduction, *Chromatic Algorithms* analyzes electronic color through the material history of aesthetics and the philosophy of technology. Cutting across these approaches is a fundamental polemic: on the one hand it is argued that color inheres in objects in the external world while on the other hand it is argued that color is a phenomenon of interior, subjective perception. This polemic extends back to the origins of Western thought and to the history of aesthetics in particular.

Classical Color: Two Extremes

I begin with subjective color. Following Empedocles' emission theory of vision, Plato (424–348 B.C.) approached color through the lens of subjective perception and proposed that the "pores of the eyes" consist of "fire and water" through which humans perceive white and black.[10] In Plato's creation myth, the *Timaeus*, Socrates argues that "the pure fire which is *within us* . . . flows through the eyes in a stream smooth and dense . . . " and later in this same passage that "the light that falls from within [travels to] meet an external object."[11] In this way, a subject's visual perception is mediated and shaped by

what he or she sees in the world. Given Plato's metaphysical prioritization of abstract mathematical Forms, it should come as no surprise that such mediated visions proved to be fundamentally deceptive and unreliable.

On the objective end, Aristotle (384–322 B.C.) formulated an empirical theory of vision rooted in the colors that he observed *in the world*, which he then classified into various systems. In his discussion of the rainbow he determined that light and color must necessarily move through a transparent medium in order to be seen: "Colour sets in movement not the sense organ but what is transparent, the air, and that, extending continuously from the object . . . sets the latter in movement."[12] Color for Aristotle was not *in* the subject—the "sense organ"—as it was for Plato, but rather, in the objective world. In his critique of Plato's emission theory, he explains: "If the visual organ proper were really fire, which is the doctrine of Empedocles, a doctrine also taught in the *Timaeus*, and if vision were the result of light issuing from the eyes like a lantern, why should they not have had the power of seeing even in the dark?"[13] For Aristotle, and many after him (namely the tradition that builds from Newton onwards), light and color exist as physical properties of objects in the external world. Herein lie the seeds of the two dramatically distinct approaches to color in the West: the subjective and the objective.

While catoptrics and dioptrics were not formally distinguished as separate fields of study until Euclid's *Optics* (aprox. 300 B.C.), early traces may be identified in the two above theories. *Dioptrics* involves the study of refraction, or, as Plato suggested, light passing *through* transparent or translucent bodies.[14] The field derives from the notion of *perspicere*, or "seeing through" and includes such phenomena as electronic displays, whether cathode ray tubes or liquid crystal, prisms, rainbows, and telescopes. Currently dioptric methods guide research in color physics, optics, and cognitive science.[15] In contrast, *catoptrics* derives from the Greek κατοπτρικός, meaning specular, and refers to the branches of optical research concerned with "looking at" things and objects, such as projection screens (cinematography) or reflexive surfaces (mirrors), and as such, it is more in line with Aristotelian observation. Catoptrics are bound to the "illusionizing potential of projection [and] the production of artificial reality," Siegfried Zielinski explains, associated more with artifice and play than visual or interior truth.[16] This is also why Alex Galloway suggests that catoptrics can be associated with the Greek god Hermes, known for trickery, deceit, and the origin of hermeneutics, while dioptrics can be aligned with Iris, the Greek goddess of the rainbow, for whom light and color are immanent and pure.[17] Hermetic light must be decoded and interpreted (like a commodity fetish or religious text) but Iris-based colors are innate; a Spinozistic phenomenon available for immediate visual consumption.

The polemic between refracted (dioptric) and reflected (catoptric) light can also be extended to *lux* and *lumen*, concepts that derive from theological

sources like the Bible, the work of Abbé Suger or the history of Western optics.[18] In the early seventeenth century, Jesuit mathematician Franciscus Aguilonius argued that *lux* characterized the properties of light from an *opaque* body while *lumen* connoted light activity in a *transparent* body.[19] Opacity and transparency then concern two modes of mediation that, in their modern form, appear as “additive” and “subtractive” color systems. Additive color systems, such as television sets, rainbows, neon signs, and computer displays, *generate* and *emit* light. The primary colors of an additive system are red, green, and blue. When these primaries are combined, they produce transparent white light.[20] In contrast, subtractive color systems like paintings, books, apples, and cars, are chemically based color systems that *reflect* color from a material substrate. Blue, red, and yellow are the primary colors of a subtractive system—often referred to as cyan (C), magenta (M), and yellow (Y)—and when they are mixed together they produce black (figure 1.1).

1.1

In sum, color is and has always been a highly ambivalent phenomenon, perpetually oscillating between the extremes of spirit and matter; light and pigment; white and black; subject and object; and the sacred and the synthetic. A number of color’s mysteries and ambivalences remain active and unresolved in Western culture; however, in the age of Reason and the Enlightenment many of their ambiguities and uncertainties were seemingly frozen, split, and solved under the reifying gaze of technics, industry, and modern science.

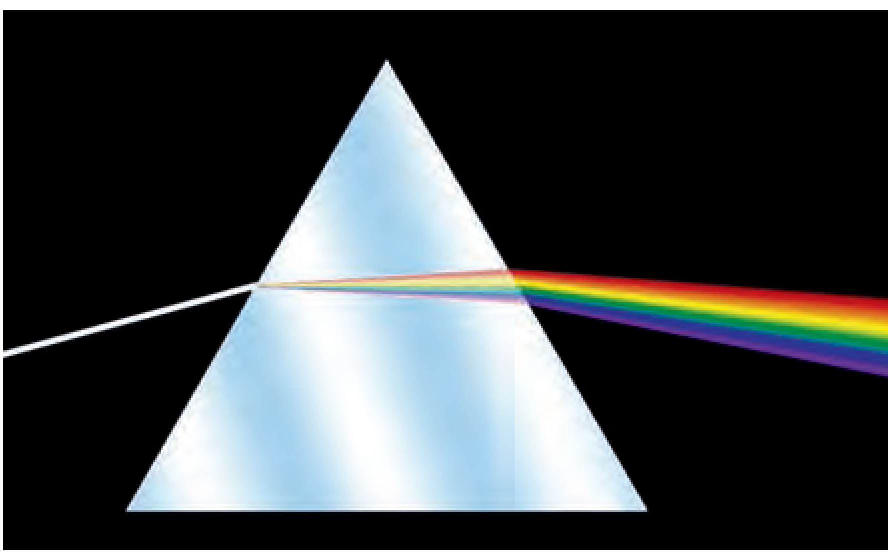
Clear White Light

The clarity of modern Reason appeared to lift the cloudy veil cast over sacred color. Complemented by developments in optical technologies, Reason became a metonym for pure light and truth that, together, restructured the

1.1 Additive (left) and subtractive (right) color systems. In the additive system colors combine to create white, in the subtractive system colors combine to create black.

conditions of possibility for (visual) knowledge. In the late sixteenth and seventeenth centuries alone Giovanni Battista della Porta (1537–1615) developed the *camera obscura*; Johannes Kepler (1571–1630) developed the first theory of optic lenses; Galileo Galilei (1564–1643) advanced work with telescopes; and René Descartes (1596–1650) employed geometry to illustrate the principles of light refraction in dioptric media. As light and space were territorialized through carefully crafted optical experiments, that complex and unreliable thing called color became a mere subordinate to pure and true white light. The shift was furthered through the work of Sir Isaac Newton (1643–1727), who, working in a dark chamber sealed off from the (life)world, demonstrated in 1704 that all spectral colors combined into white light (figure 1.2).[21] As a derivative of light, color could be measured and quantified into seven distinct hues, a theory that laid the foundation for future color science and the physical study of color.[22]

1.2



There are, however, problems with Newton's theory of color and his account of white light. Despite the fact that he was well aware of the subjective aspects of color, his thesis—at least the way in which it has been repeated through history—disavows many of the paradoxes and ambiguities that make color a dynamic and contextual phenomenon. Any pursuit of pure "transparent" knowledge, it has long been acknowledged, is doomed from the start, clouded by its own ideals and abstract methods. Such misguided beliefs in anything like a readily available "pure white light" or "transparent truth," Heidegger has argued, applies to the Enlightenment at large, and to Descartes and Kant in particular.[23] In this paradigm the production of (theoretical) "knowledge" and (calculated) "truth," while connected to empirical vision and optics, were

so abstracted from the lifeworld and lived experience that they ultimately *blocked* rather than enriched one's capacity to access truth, in a phenomenological sense.

And yet beliefs in pure white light and scientific truth remain intact. Moreover, pure white light continues to carry anachronistic theological associations with the brilliance of the rising (Apollonian) sun, a Christian God, and the transcendental (masculine) spirit. It's symbolic value runs so deep into the practices of Western, patriarchal, Caucasian culture and its claims to authenticity, origin, innocence, and truth that it has become "natural" to view color as its dirty and degraded counterpart. Where light comes from God and the divine universe, color seeps in from the discarded residue and waste of the fallen, material world.

In Western aesthetics, color is not only secondary and supplemental to Reason and truth but also to the unwavering strength of line, form, and structure. This particular polemic came to a head during the height of the Italian Renaissance, even though its roots, as noted, can be traced back to Plato's theory of images and Western chromophobia in general. The particular form it assumed in the mid-sixteenth century was through the discursive and artistic oppositions between Florentine *disegno* (line, form, or design) and Venetian *colore* (colorism, or, brushstroke), that is, whether or not "painting should be organized around meaning or affect," as Sylvia Lavin puts it.[24] In contrast to *colore*, the (unstructured) use of color and brushwork, *disegno* privileges line, form, draftsmanship, and rational compositional space. The two camps of *colore* and *disegno* straddled either side of Michelangelo, where *disegno* was emblematic of the work of Pontormo and Raphael, and *colore* of Giorgione and Titian. Writers and critics from Leon Battista Alberti through Paolo Pino, Giorgio Vasari, Lodovico Dolce, and later Heinrich Wölfflin helped reaffirm one camp over the other and thus perpetuate the assumed metaphysical distinction between them. Vasari, for instance, founded the Florentine Academia del Disegno in 1563, an institution that formally acknowledged, taught, and merited the prominence of *disegno*. Vasari valued *disegno* for its links to the clarity of the mind (in conceiving of certain forms) and their corresponding realization in material form. Vasari believed he was living in a period of perfect art, lost since Antiquity, but reembodied in Michelangelo's *disegno*. It should come as no surprise that *disegno* won this debate and remained dominant in Europe until well into the nineteenth century. (In chapter 7, I bring this tension between *disegno* and *colore* into my analysis of the Photoshop cinema.)[25]

Privileging light as clarity and truth over that which is feared and unknown is also the story of color in Immanuel Kant's (1724–1804) aesthetic theory. For his "transcendental aesthetic," Kant reserved only those a priori properties of the mind that excluded color. In 1781 he wrote that

1.2 Working in a dark chamber in the late seventeenth and early eighteenth centuries, Sir Isaac Newton demonstrated that color derived from pure white light.

> colors are not necessary conditions under which alone objects can be for us objects of sense. They are connected with the appearances only as effects accidentally added by the particular constitution of the sense organs. Accordingly, they are not *a priori* representations, but are grounded in sensation . . . Further, no one can have *a priori* a representation of a color.[26]

While Kant's third critique altered some of his earlier views on color, overall color remained secondary. For instance, in this third critique from 1789, he wrote that the "colors which light up the sketch belong to charm; they may indeed enliven the object for sensation, but they cannot make it worthy of contemplation and beautiful."[27] In the tradition of Plato, Descartes, and Newton (to name only three) Kant thus further authorized color as a secondary and inessential phenomenon; as a mere ornament and adjunct to "The Beautiful and the Sublime." I will not go into further detail about color in the history of aesthetic philosophy here.[28] Suffice it to note that from Antiquity through the nineteenth century, color was subject to rampant aesthetic, epistemological, and ideological chromophobia. "Bound up with the unreliability of the human senses," as Jonathan Crary puts it, color "could tell [philosophers] little or nothing about what they believed to be the most important 'permanent' truths about reality."[29]

Dirty Color

The dark (feminine) view of color is frequently held responsible for color problems, while it is also applauded for inciting visual delight. Such a view allows pigment-based colors to concurrently act as symbols of pleasure, deception, and deceit. One may show one's "true colors" in a moment of vulnerability, intimacy, or the expression of raw emotion, but just as easily one may hide behind a mask of colorful makeup and concealer. In Latin, the term *colorem* is related to *celare*, which means to hide or conceal, but in Middle English "to color" means to embellish or adorn as well as to disguise, "render specious," or "misrepresent."[30] The situation becomes one where, as Albers puts it, "In order to use color effectively it is necessary to recognize that color deceives continually."[31]

Color's capacity to simultaneously conceal and reveal, or attract and repulse, invokes the ambivalence of the *pharmakon*. In critical theory the *pharmakon* is traditionally associated with the *Phaedrus*, where Socrates aligns it with the then-new technology of writing. As a new medium, the *pharmakon* is a prosthetic that both preserves and replaces human memory; both a remedy and poison. But as both Derrida and Stiegler point out, as a supplement technics is also originary and therefore fundamental to being. The same logic applies to color as a *pharmakon*. For example, in Plato's *Philebus*, *Republic*,

and *Cratylus*, Derrida notes, scholars have translated the term *pharmakon* as "color." In the *Philebus*, the colors in a painter's palette are seen to be both constructive and destructive: used to create a new world and to deceive the eye with artifice and illusion. In the *Republic*, color is translated to *pharmakon* to imply witchcraft or magic, a "cosmetic concealing the dead under the appearance of the living."[32] Color is dangerous because it is too potent and attractive, preventing one from turning away from it, yet also essential for life, vitality, and creation.

To say that color is a *pharmakon* is to say that color is and has always been a kind of technology. So while my focus in the following chapters lies with computer-generated color, it is nonetheless crucial to note here that *color of any kind is also always a matter of technics*. That this has been acknowledged only in certain fields since the Industrial Revolution is beside the point. Color used in cave painting is still a matter of chemistry, just as color in the atmosphere involves actual water droplets, sunlight, and dioptric media. If, as I discussed in the introduction, human life, history, and culture must in the first instance be approached alongside and through technics, then so too must color. Whether through its ochers, its minerals, or its silicon graphics chips, color's dirt and matter connects us, however reluctantly or ambivalently, to technics and artifice, just as it does to metaphysics and theology, politics and ideology, and the depths and darkness of the earth, the world of chaos, eroticism, and Dionysian ecstasy.

But equating color, and generally pigment-based color, with dirt, darkness, deception, and the feminine, is only half the story.[33] Not only does the feminization and foreignization of substance-based color speak directly to ongoing fears and a fundamental distrust of certain kinds of color in Western culture, it also points to one of the ways in which Western chromophobia extends to almost any substance or being that is "other" than white, patriarchal, or Christian. As David Batchelor puts it, in Western culture:

> [t]he purging of color is usually accomplished in one of two ways. In the first, colour is made out to be the property of some "foreign" body—usually the feminine, the oriental, the primitive, the infantile, the vulgar, the queer or the pathological. In the second, colour is relegated to the realm of the superficial, the supplementary, the inessential or the cosmetic. In one, colour is regarded as alien and therefore dangerous; in the other, it is perceived merely as a secondary quality of experience, and thus unworthy of serious consideration.[34]

Color must therefore be seen as something deeply historical, material, and ideological, at the core of the always already Other that perpetually threatens to unveil and undermine the notions of truth, purity, origin, and order that underwrite Western culture.

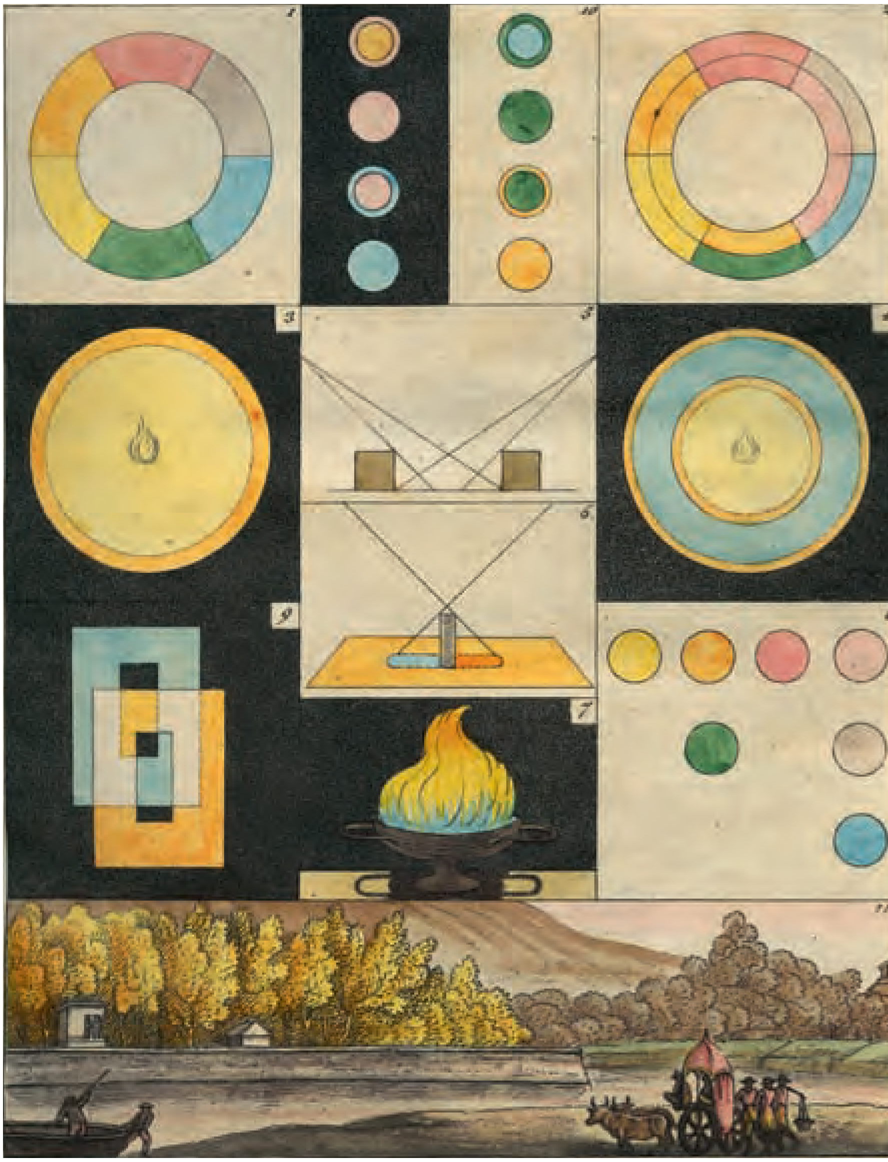
Modern Colors: Goethe's Cloudy Perception

[We need] a way of thinking where white is no longer the opposite of black, but rather its positively discolored reflection.
—François Laruelle[35]

That there is absolute truth or pure objective knowledge was a worldview that was in many ways put to rest in the nineteenth century. In 1810, Johann Wolfgang von Goethe (1749–1832) returned color to its ephemeral and mystical Homeric lifeworld. In his *Zür Farbenlehre* (*Theory of Colors*), he glorified color for all of its inconsistencies and complexities, making the cloudiness of subjective perception, in marked contrast to Newton's color theory, the most central and sacred to experience, in service of achieving the "highest aesthetic ends."[36] In color studies, Goethe's work marks a paradigm shift from so-called objective, classical color theories to the world of subjective perception. Also informing this shift are interlocutors including Jean-Jacques Rousseau (1712–78), whose notion of the sovereign subject shifted credibility towards the individual's experience, and Immanuel Kant, whose "Copernican turn" further validated subjective perception within formal philosophy.

Goethe was equally influenced by studies in optics and electricity, fields that had also turned to the human subject as the source of (mediated) truth and knowledge. Research in electricity began with Luigi Galvani and Alessandro Volta, who approached the human body as the site—the conductor—of electrical energy and visual experiments. In the eighteenth and early nineteenth centuries, Johann Wilhelm Ritter experimented with nerves and muscle fibers, making his "own body his laboratory workhouse." At the time, Czech physiologist Jan Evangelista Purkyně was also interested in entropionic images (and opium), and he began folding his eyelids inward against his eyeball to produce images "with no direct visual reference to the outside world" from which he established different color zones within subjective color perception.[37] Inspired by these experiments, Goethe began to poke himself in the eye, stare at the sun, take drugs, spin colored discs, and send electricity through various body parts. His research was unconcerned with the so-called purity of light, observed from the interiors of a dark and isolated chamber, but instead with colors seen in the murky, mediated world and on the edges of perception (figure 1.3).

Goethe's color studies are summarized in *Zür Farbenlehre*, a book divided into three main parts. The first section is concerned with physiological color: subjective experiences of color such as halos, dazzling color, afterimages, and phenomena appearing to (sun-)damaged or otherwise "pathological" eyes. "Physiological colours," he wrote, "belong to the subject—to the eye itself. They are the foundation of the whole doctrine."[38] The second part concerns physical, dioptric colors that, as noted, involve the phenomena of light and color passing through physical media.[39] The third part addresses object or chemical colors



1.3

that inhere in substances like dyes, textiles, worms, minerals, pigments, and plants. Chemical colors have a greater tendency to "fix" their hue for longer periods of time, though they may change (for instance, butterflies express radically different colors throughout their metamorphosis). The shorter fourth and fifth parts critique color studies in philosophy and linguistics, and especially Newton's physical color science.

Zür Farbenlehre openly leverages a tirade against Newton's 1704 *Opticks* and his thesis that color is exclusively a physical phenomenon emanating from pure white light. Newton's approach to color "retarded" color studies, Goethe

1.3 Johann Wolfgang von Goethe, "Diagram 1," hand-colored engraving from *Zür Farbenlehre* (*Theory of Colours*) (Tübingen: Cota, 1810). Courtesy of the Goethe-Museum Düsseldorf/ Anton-und-Katharina-Kippenberg-Stiftung, Düsseldorf, Germany.

argued, as it removed color from the lifeworld and the "the perishable and variable properties of natural phenomena [and] lived experience," as Crary puts it (albeit in regards to the overall standardization of modern color).[40] As a critique of the positivistic sciences, Goethe buried his chapter on dioptrics—the primary focus of optical research since Galileo—in the middle of the book, placing his chapter on the cloudy colors of subjective perception first.

In sum, Goethe's research guided color studies into a new paradigm wherein *any* body capable of seeing or perceiving could be constituted as a self-knowing body, regardless of how cloudy or opaque one's perception was. In the nineteenth century, perceptual color became synonymous with a new subjectivity; a modern psyche that actively shaped his or her own reality. Moreover, these cloudy and unclear visions—what Goethe called *das Trübe*—were precisely the conditions under which the Romantics and eventually the phenomenologists would lay claim to color as a force and phenomenon that resisted and opposed rational and detached methods in color psychology, science, and industry. However, just as these subjective approaches to color emerged to reclaim the gestalt of the lifeworld, they were caught in the reifying gaze of the nineteenth century's optical sciences.

Psychophysics

In the nineteenth century, scientists like Gustav Theodor Fechner, Ernst Heinrich Weber, Hermann von Helmholtz, Johannes Müller, James Clerk Maxwell, and Thomas Young pioneered the scientific study of optics and perception. They saw value in Goethe's "embodied" color and likewise located visual truth in the corporeal body. But no sooner was this body identified as the source of visual knowledge than it was also *removed and abstracted from the world*. In pursuit of an "ideal subject" of vision, perceptual processes were isolated and idealized into *objects for* rational observation and calculation (it is precisely this reification that comes under the gun in Husserl's, Heidegger's, and Merleau-Ponty's phenomenology, as I note in the introduction).

Grandfather of psychophysics Gustav Theodor Fechner (1801–87) set a general equivalency for measuring thresholds and standards in visual perception. In his *Elements of Psychophysics* he established the "Weber-Fechner" law of "just noticeable difference" to demonstrate how a mathematical formula could be used to determine and extrapolate on the minimal amount of (light or sound) stimuli needed to elicit a certain response. Central to his claim was the observation that, as stimuli were repeated, they would also need to be increased in intensity to account for the weakening in response on the part of the subject (due to things like fatigue). Given this rate of diminishing return, his law could, ostensibly, be used to mathematically determine the logarithmic tendency of a subject in relation to external stimuli. While there are obvious

problems with the assumed "standard" observing subject, Fechner's research nonetheless paved the road for future developments in technical color standards. In short, through the Weber-Fechner law, the smallest perceptible difference or threshold in perceived light stimulus could be used to establish a quantitative logarithmic relationship, or 1:1 equivalency between stimuli and sensation, and thus color affect becomes color quanta.[41]

Fechner's theory also introduced another problem. While his empirical science allowed the mind and body to (re)connect, albeit through abstract quantification, a major shortcoming of the method was the fact that its claims to an internal reality were only ever extrapolations of externally administered stimuli. That is, on the side of the stimulus, not the response. Any quantitative measurement of sensation was always only a hypothesis, cued by quantifiable visible responses. As Fechner puts it, "The fundamental experiences in the entire field of psychophysics can only be found in the domain of external psychophysics, because only this is accessible to direct experiences . . . the physical exterior world is connected to the functioning of the mind only by the mediation of the physical world."[42] This shortcoming was hardly unique to Fechner's work.

German psychophysicist Johannes Müller (1801–58) also observed and analyzed the human body as a factory of sensations. In 1838 he determined that light and color were mere actions of the retina, nervous prolongations sent to the brain that could be measured, extracted, and controlled through distinct stimuli and response systems.[43] In *The Comparative Physiology of the Visual Sense in Man and the Animals* (1826), he had already determined through his "doctrine of specific nerve energies" that the senses could be arbitrarily divided into distinct systems, therein setting the stage for each and any color stimulus to correlate with an equally arbitrary "specific energy" on the optic nerve.[44] And thus there was no longer any need for an experience of *actual color*, as found in the lifeworld, only the quantified set of stimuli needed to simulate it. Because the phenomenal, qualitative experience of the subject was here barred from the start, quantitative external color measurements logically became the key to any "truth" and knowledge about color and what, where, or how it could exist.

By presuming light rays were always moving through materials of some sort—like the atmosphere or the human body—Müller also supported an undulatory model of perception, endorsing light and color as always already mediated and therefore dirty. When colors were animated, he argued, they merged to produce grey, not a pure and pristine white, as Newton had argued. Müller's scientific justification for dirty color not only undermined Newton's theories of simple and pure rays of light, or the corpuscular theories of light proposed by Descartes, but also provided a scientific endorsement of Goethe's cloudy color theory, which had initially been lambasted by the scientific community in the early nineteenth century.

Hermann von Helmholtz (1821–94) studied under Müller and like his teacher he observed the "flight of colors" in afterimages. He paid special attention to the way in which colors faded out of sight by passing through a specific order. "Everything our eye sees," he wrote, "is an aggregate of coloured surfaces in the visual field—that is its form of visual intuition."[45] Yet contrary to his teacher's insistence that organic and inorganic life were distinct, using Fechner's psychophysical law Helmholtz demonstrated that organic life could be measured and quantified in just the same way as inorganic things. James Clerk Maxwell (1831–79), who engineered research on feedback in the steam engine and color photography, later extended Helmholtz's research by "giving mathematical expression to the data stream of sensual perception," for which he developed a proto–analog computer mechanism to articulate color perception in the form of an equation.[46]

In sum, in this body of research one finds the emergence of standardized models of color vision, such as the International Commission on Illumination (the CIE lab system), which proposes a universal "standard" observer for all color values; the precursors to research in neuroscience and cognitive studies; and the emergence of what I term "algorithmic color," namely, the transformation of color from a qualitative phenomenon to a code, formula, quantum, or mathematical equation. This brief overview of color in nineteenth-century science demonstrates how it was seen to be subjective and essentially optical, but also a quantifiable and calculable phenomenon. The overview also points out that quantitative analyses of life systems (here the human body) were already in place when Claude Shannon developed information theory in the mid-twentieth century. Once embodied perception had transformed into a series of "electric potentials and logarithmic transfer functions," as Kittler puts it, the epistemological ground was cleared for human life to be "divested of all its humanity," and color of its sacred attributes.[47] Now fully extracted from the lifeworld, technical color was all that remained for the progeny of Modern art and aesthetics.

Goethe's Legacy

Strangely, Goethe's color theories spread to the sciences in the 1830s and 1840s, *before* they spread to art. In fact it was primarily by way of science that artists and designers writ large came to adopt Goethe's color theories.[48] Helmholtz's *Treatise on Physiological Optics* (1867), for instance, introduced artists to the distinction between additive and subtractive systems as well as other refinements of color theory while Maxwell, as noted, produced the first color photograph in 1856, furthering studies in additive color mixing for visual imaging. But by far the figure that had the most influence on color in nineteenth century art, fashion, and design was French chemist Michel-Eugène Chevreul (1786–1889).

Chevreul worked as a superintendent in the dying department at the Manufacture Royale des Gobelins, the national tapestry workshop in France. In 1824 he became director when he quickly identified problems with the intermixing of colors in the weaves' warps and wefts, color fading, and brilliance. He observed how colors frequently faded into each other, not because of the dye but because of what he termed "simultaneous contrast" wherein one color was affected by its neighboring color and as a result, there was an overall shift in both hues (see figure 4.14). In other words, the color problems were due to optical mixing, *not the chemical nature of the dyes*.

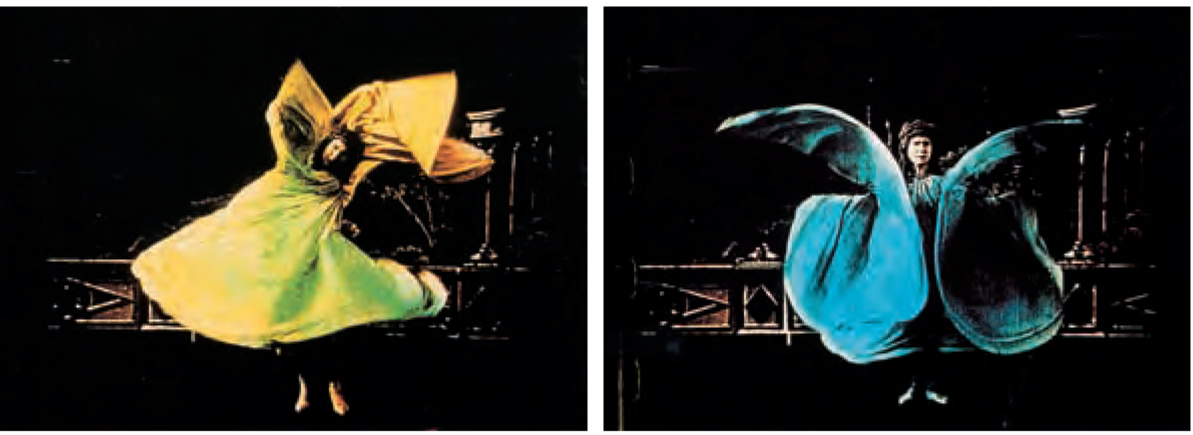
To solve these problems Chevreul turned to Goethe's and Helmholtz's color theory, which he attempted to put into practice by quantifying and standardizing the perceived color effects through an elaborate color wheel and diagram. Unfortunately, his detailed science of color mixing proved impossible to implement. For one thing, his color laws were based on theoretical and highly subjective optical responses to color, not the chemical laws of color or dye mixture formulas. Second, his intricate design for a color circle contained 14,400 dye colors that, at the time, were unstandardized so a detailed chart would likely become useless by the time the next batch of dyes rolled around. Furthermore, his color circles used "natural" color dyes ("organic synthetic dyes") that became obsolete in the 1860s, after William Perkin and others noted below found ways to produce synthetic colors from coal tar.[49]

Chevreul began lecturing on color in 1828. However, his book *De la loi du contraste simultané des couleurs et de l'assortiment des objets colorés* (*The Principles of Harmony and Contrast of Colours*) was not published until 1839. And while it was unsuccessful within the dye industry, it was largely influential in the art, fashion, and visual cultures of the nineteenth century. In particular, his work influenced modern painters and color theorists including Ernst Brücke's *Die Physiologie der Farben für die Zwecke der Kunstgewerbe* (1866); Auguste Laugel's *Optics and the Arts* (1869); Charles Henry's *Introduction to Scientific Aesthetics* (1885); Charles Blanc's *Grammar of the Arts and Design* (1867); and Ogden Rood's *Modern Chromatics* (1879). Chevreul's color theory provided systematic explanations for the mysterious laws of color and the material experience of subjective color perception, offering guidance and explanation as to how one could avoid shifting colors, gauche color combinations, and disharmonic wardrobe ensembles.[50] In turn, the above noted titles, and Rood's in particular, offered artists and visual designers further accounts of the laws of color, both in terms of optical perception and color mixing.

By way of these Goethe-inspired sciences then, subjective theories of color mixing became central to art movements like Impressionism and Post-Impressionism. In his *Against the Enamel* of a *Background Rhythmic with Beats and Angles, Tones, and Tints, Portrait of M. Félix Fénéon in 1890*, for instance, Paul Signac depicted the world of vision as an effect of one's inner psyche and

subjective perception, no longer an objective outer world. Post-Impressionist Paul Seurat was especially influenced by both Charles Henry's 1885 theory of the "aesthetic protractor," which posited that the emotional value of a line may be measured, as well as Blanc's method for mixing color dots based on juxtaposition. In combining these two approaches, Seurat developed his own optical formula for painting, which we now call pointillism.[51]

Goethe-derived color theory also entered experimental light art and performances in the nineteenth century, most notably through the work of Charles Babbage and Loïe Fuller. Babbage, often cited in new media histories for his analytic engine, was also interested in color effects in dioramas. In the 1840s he proposed to mount a "rainbow ballet . . . using four limelights with coloured filters which would project overlapping beams on the white-clad dancers." Unfortunately due to fire hazards the project never materialized.[52] Shortly after Edison developed the incandescent bulb around 1880, however, American designer Loïe Fuller began building complex light shows and performances that pivoted on color effects (figure 1.4). She used light boxes, rotating colored filters, a double lantern for mixing colored beams, and a glass floor lit from below.[53] As Adrian Bernard Klein describes it, Fuller used "vertical shafts of light projected upwards from beneath the stage. In these narrow cones of light, the dancers whirled, twisting shreds of gauzy fabric, while the beam was rapidly altered in colour; and the effect was like that of a figure enshrouded in a silent and iridescent column of flame."[54] Sacred color had seemingly returned.



1.4

Similar light and color experiments also appeared in the cinematic avant-garde, in the work of Oskar Fischinger, Norman McLaren, Viking Eggeling, Len Lye, Walter Ruttmann, and Mary Ellen Bute, and again in the 1960s. In many ways, the expansion of the perceptual field in the 1840s is analogous to the color experiments with art and technology in the 1960s and early 1970s, which I analyze in chapters 2 through 4: both occurred in moments of unprecedented innovation and unholy fusions between art, color technology, and science.

Bauhaus Color

In the twentieth century, Goethe's influence continued to spread to movements like German Expressionism (namely in the work of Ernst Ludwig Kirchner), and especially to the art and design at the Bauhaus. In 1919 German architect Walter Gropius established the *Staatliches Bauhaus*, or simply Bauhaus, in Weimar, Germany. The school had an innovative art and design program and at the core of its curriculum was color theory. Its approach to color merged scientific and philosophical methods and was taught by Johannes Itten and Josef Albers (who was also a former student of the school). When the Bauhaus was forced to move and eventually close during World War II, many members moved to the United States, including Albers, who began teaching at the Black Mountain College and then at the Yale Graduate School of Art, where he taught color theory from 1950 to 1958. (figure 1.5–1.6).

1.5

Like Goethe, Albers was interested in how color behaved, not in abstract principles or ideals, as the psychophysicists were or Wilhelm Ostwald, a German chemist and amateur painter who in 1916 proposed a highly intricate and empirical color ordering system that Albers strongly opposed.[55] Color was unfaithful to *any* theoretical system, Albers insisted, and therefore, in order to learn about color, one had to experience and use it, not abstract it into a

< **1.4** Hand-colored Pathé film, circa 1907. In the 1890s, American dancer Loïe Fuller began to integrate colored lights into her ethereal performances.

1.5 Josef Albers, Color Theory Class, 1944. Summer Institute by Joseph Breitenboch, Black Mountain College Research Project. Image Courtesy of the North Carolina Office of Archives and History of the North Carolina Department of Cultural Resources.

1.6 pre-determined ordering system. His studio classes thus involved empirical and active engagement with his students and their color assignments. In 1963 he wrote, "With the discovery that color is the most relative medium in art, and that its greatest excitement lies beyond rules and canons . . . we learned that their often beautiful order is more recognized and appreciated when eyes and mind are—after productive exercises—better prepared and more receptive."[56] Also in 1963 Albers published *The Interaction of Color*, by which time the Bauhaus's color and design principles—qua Goethe—had been absorbed into numerous American art and design school curricula. The attraction to these color theories came from the way in which they approached color based on how it was *actually seen* in the world not on how it was *supposed* to behave, based on theoretical or abstract notions.[57]

Romantic Color in Critical Theory

Less acknowledged in Goethe's legacy is the way in which his color theory influenced critical theory. It is well known that Romantic philosophers like F. W. J. Schelling, G. W. F. Hegel, and Arthur Schopenhauer were attracted to Goethe's phenomenological approach to color and the way in which it merged sensation and reason.[58] Contrary to Kant and the "chromophobic" philosophers who came before him, both Goethe and Hegel glorified the spiritual and majestic powers of color. Hegel wrote, "[A]ll the spatial relations and differences of objects appearing in space, are produced in painting *only* by color."[59] Following Goethe, Hegel maintained that color was a form of expression that could be used to achieve a "sublation" (*Aufheben*) of art into philosophy and ultimately into spirit. It was Schopenhauer, however, who most closely followed Goethe's work, especially in his 1816 *On Vision and Colors* where he argued that the "[c]olors with which objects appear to be clothed . . . are entirely in the eye alone."[60] Filled with color, the subjective eye *was* the lifeworld. Likewise, in 1935 Heidegger wrote, "Color shines and only wants to shine. When we analyze it in rational terms by measuring its wavelengths, it is gone."[61]

It is logical that Goethe's romantic view of color extended to these phenomenologies and art theories, but less obvious is the way in which it has also been absorbed into critical theory. In 1914, for example, Walter Benjamin wrote that a "pure vision is concerned not with space and objects but with colour . . . The imagination can be developed only by contemplating colours and dealing with them in this fashion."[62] Or, in 1957, Adorno wrote:

> To want substance in cognition is to want a utopia. It is this consciousness of possibility that sticks to the concrete, the undisfigured. Utopia is blocked off by possibility, never by immediate reality; this is why it seems abstract in the midst of extant things. The inextinguishable color comes from nonbeing. Thought is its servant, a piece of existence extending—however negatively—to that which is not. The utmost distance alone would be proximity; philosophy is the prism in which its color is caught.[63]

Like the phenomenologists, a number of critical theorists idealized and romanticized *light*-based color well into the twentieth century. A slight shift occurred in deconstruction and poststructuralism, where, while color was still idealized, it was not esteemed for any utopic valency but rather for its *intrinsic capacity to undo form and transgress meaning*.

For instance, in 1975, Roland Barthes wrote: "If I were a painter, I should paint only colors: this field seems to me freed both of the Law (no Imitation, no Analogy) and Nature."[64] For Jean Baudrillard, color was also an elusive and nonsensical phenomenon:

> No analysis of the vibrations of light will ever explain the sensory imagining of colours. No digital optics will ever explain red in its literalness, in its absolute

1.6 Josef Albers, Drawing Class, 1939–1940. Black Mountain College Research Project. Image Courtesy of the North Carolina Office of Archives and History of the North Carolina Department of Cultural Resources.

difference from blue or green, any more than any logic will ever explain the relation of the sign to the thing, of red to the term "red," which is just as indefinable as red.[65]

Similarly, in 1996, Stephen Melville followed Derrida's deconstruction of the *parergon* to argue that color is "everywhere bounded," yet it "repeatedly breaks free or refuses such constraints." And when this occurs, he continues, it is color that "awakens questions of the frame and support."[66] This sense of pure aberrancy and utter transgression, a romantic and idealistic sentiment to be sure, is also how and why color is celebrated in the work of Ludwig Wittgenstein and Jacques Derrida.[67]

That the Western critical and philosophical tradition maintain a pure and idealistic view of *light*-based color, even if this is a purity of transgression, is a problem for synthetic color. To turn away from color's scientific and technical attributes will not solve anything about color and the problems it faces in an age of hypertechnology and informatic media. In essence, these approaches perpetuate chromophobia, even if by negation. It is not surprising that the expressionistic, subjective, and optical approaches to color that characterize color theory from Goethe through the mid-twentieth century began to fall apart in the postwar era of techno-rationalism, information theory, and cybernetics. To demonstrate this, in the next section I introduce an archaeology of industrial synthetic colors, from fluorescents through the Day-Glo lifeworld, circa 1969.

II. Industrial Color: Synthetics to Day-Glo Psychedelics

When it comes to the "cheap" synthetic colors of the modern world, it is remarkable how the above noted high-minded visions quickly flip to the opposite extreme. On this side of the rainbow Adorno writes: "The color film demolishes the genial old tavern to a greater extent than bombs ever could."[68] And Roland Barthes: "For me color is an artifice, a cosmetic (like those used to paint corpses)."[69] And Walter Benjamin, writing about the host of commodities for sale in the nineteenth-century Paris Arcades: "[F]alser colors [than colored lithography] are possible in the arcades; that combs are red and green surprises no one. Snow White's stepmother had such things, and when the comb did not do its work, the beautiful apple was there to help out—half red, half poison-green, like cheap combs. Everywhere gloves play a starring role, colored ones [and] long black ones . . . upon which so many . . . have placed their hopes for happiness."[70]

Such views may run alongside this study, devoted to so-called cheap and poisonous hues, whether in dye, phosphor, or liquid crystal form. More helpful, however, is Buckminster Fuller's observation that we "speak erroneously of 'artificial' materials [and] 'synthetics.'" It is a false

> notion that nature has certain things which we call natural, and everything else is 'manmade,' *ergo* artificial. What one learns in chemistry is that nature wrote all the rules of structuring; man does not invent chemical structuring rules; he only discovers the rules. All the chemist can do is to find out what nature permits, and any substances that are thus developed or discovered are inherently natural.[71]

In this view, sympathetic to my own, synthetic color, like technics, has always been integral to the lifeworld. Natural histories of color, for instance, place synthetic pigments in the early Paleolithic period (35,000 B.C.), when red earths were first used to create tattoos on the "flesh of the living" and the bones of the dead were reddened with ochre.[72] Around 3000 B.C., Egyptians also fabricated a synthetic blue pigment, a double silicate of copper and calcium, by drying out sediments from the bottom of the Nile River, which they then used to dye clothing.

Synthetic color also bears links to the history of colonialism, slave trading, genocide, and war. While I do not focus on these connections at length, they are worth noting briefly. The trade in indigo (a synthetic pigment known for its steadfast qualities and brilliant purple-bluish hue) dominated throughout European imperialism and slave trading in India and Africa, during which time Great Britain and France controlled the indigo trade from India. In 1789 the western province of the French colony of Saint-Domingue, now Haiti and the Dominican Republic, had close to 1,800 indigo plantations worked strenuously by slaves. The indigo-making process was incredibly labor-intensive. To start, according to Colesworthy Grant, "sheaves of indigo plants six feet long were crushed and placed in overnight vats of clear river water, where they were steeped for ten to twelve hours, depending on the temperature of the warm night air."[73] Napoleon's army alone ended up importing 150 tons of indigo a year, used for its fade-proof qualities to dye the uniforms of over 600,000 French soldiers.[74]

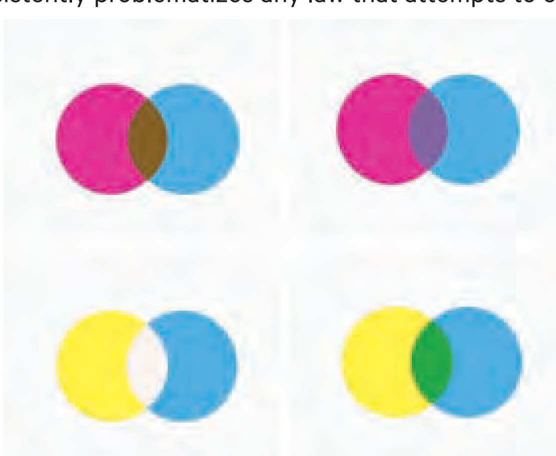
Jumping ahead, during the First World War, I.G. Farbenindustrie's (*Farben* is German for colors) constituent AGFA made color film while they also provided for the German army's chemical warfare needs. During the Second World War, I.G. Farben founded a synthetic rubber factory known as Buna in Auschwitz (featured in Pynchon's *Gravity's Rainbow*), which produced everything from synthetic oil and rubber, toothbrushes, explosives, drugs, and gas for warfare, making itself the world's largest manufacturer of dyes, films, and synthetic color products.[75] During the war the company forced prisoners, concentration camp inmates from Auschwitz and those in occupied countries of Eastern Europe, to work in IG Farben's Buna factory.[76] As Michael Taussig notes, one Farben director later charged by the U.S. government for his "proactive" role in the Third Reich testified: "I wanted to see my child, or some fish or game I had caught, in color—to see it in all its beauty. And we succeeded."[77] Against

the background of the horrors of the Holocaust, such developments hardly speak to the innocent and mystical associations color once held for the ancients or Romantics. Moreover, these are only two of many alarming connections between synthetic color, war, film history, and the slave trade, all of which demand further critical attention elsewhere.[78]

In sum, the term "synthetic color" applies to a wide variety of contexts and circumstances. In this book I use the term in three narrow senses. First to imply a *destigmatized* sense of cheapness, death, and artifice; second, to denote computer-generated electronic color (though I make one exception: in this chapter I offer an archaeology of fluorescent Day-Glo, a *chemical*-based synthetic color); and third, to contrast with the sacred in order to introduce and dismiss a false dichotomy between theology and machines. I insist throughout the book that synthetic and sacred colors are *not mutually exclusive*—the mistake of metaphysics for centuries—but rather, they are inextricably bound in ways that are neither romantic nor abstract, but concrete and tangible.

Synthetic Fluorescents and Industrial Color

Seen on traffic cones, road signs, T-shirts, nylons, nail polish, and children's toys, and commonly referred to as "Day-Glo," fluorescent colors illustrate several of color's paradoxes. For one thing, they both *generate* and *reflect* light. Fluorescents are a threshold phenomenon that are both additive and subtractive, light based and pigment based, and as such they exemplify how color consistently problematizes any law that attempts to order or classify it (figure 1.7).



1.7

To act as a light source, fluorescents absorb ultraviolet rays, a form of electromagnetic radiation that falls just beyond the blue end of the visible color spectrum. This energy is then transformed, reflected, and reemitted, but because fluorescents are capable of absorbing ultraviolet rays *as well as* naturally visible electromagnetic frequencies, the light they emit is stronger and brighter

than other colors. For example, the eye perceives Day-Glo fluorescents at a rate 75 percent faster than ordinary colors. Day-Glo colors also shine three times as strong as ordinary colors, and they can seduce the human eye 59 percent of the time to return for a second look.[79]

The fluorescent palette, while bright and intense, is also cold. That is, the palette appears more bluish than other colors or objects lit under conventional yellow, indoor, or incandescent light sources. When Aristotle first observed fluorescing in nature, he noted that "some things which are neither fire nor forms of fire seem to produce light by nature."[80] In scientific terms, he correctly distinguished the light that radiates from hot objects (known as incandescence) from light generated without heat (known as luminescence). Luminescents, such as fluorescents, burn phosphors to release light with extreme efficiency and produce only a negligible amount of heat, as opposed to other light sources, which are relatively warm. This explains why fluorescent and phosphorescent colors are cold colors and exist in cold media, both empirically and perceptually.

Another example of cold color is televisual color. Until recently television sets used cathode-ray tubes (CRTs) to produce phosphorescent light. CRT television sets contain a vacuum tube and grid mediated by a cathode and an anode pole that emit a narrow beam of electrons. The electrons are accelerated to a high velocity as they are shot through the guns toward the phosphor-coated screen, fluorescing at the point where the electrons strike. The resulting luminescent glow is called a "trace-point."[81] And while television colors fluoresce, they do not produce fluorescent colors like Day-Glo. Day-Glo is a *pigment*-based color that uses ultraviolet light to amplify its sizzling effect, whereas television is a light-based, additive color system that generates colors predominantly within the visible part of the spectrum. (I will further expand on the nature of TV as a cold medium in the next chapter.)

Moreover, when fluorescent colors reflect light, they do not follow the same laws that other spectral colors do but instead operate according to their own laws. Think of a cherry red car or light blue shirt. Each object absorbs electromagnetic rays in the atmosphere and reflects back all colors *but* cherry red or light blue, respectively. But fluorescent colors absorb *both* visible light and ultraviolet rays and transform them by shifting the reflected color down one hue. Scientists have named this effect the "Stokes shift," after the Irishman and child mathematics prodigy Gabriel Stokes.

Stokes also coined the term "fluorescence" after he placed a piece of blue glass in front of a sunlit hole in 1852. Behind the glass, he positioned a beaker of yellow liquid quinone solution (a natural fluorescent chemical found in plants) and discovered that it produced a strong yellow glow, which he named fluorescence. Stokes next identified the "degradation" effect of reflected light, which he observed in red flowers at dusk. At this time of day, the red flowers appear

1.7 The distinct behavior of fluorescent colors under ultraviolet light (left) is contrasted with fluorescent colors under visible light (right).

bluer than earlier in the day because at dusk there is a cooler, bluer light in the diffuse atmosphere. Fluorescents intensify using a similar logic: they may receive an orange light stimulus but when mixed with bluish-ultraviolet rays, they will shift the hue down to reflect yellow or even green.

In 1833, while experimenting with coal tar, a brown or black viscous byproduct and waste material from coal mines (coal tar results from the carbonization of cola in coke), German chemist Friedlieb Ferdinand Runge applied coats of the tar mixed with other chemicals to his outdoor fence to keep dogs out and prevent them from urinating on it. His plan did not work and the neighboring dogs continued to urinate on his fence. Runge was pleasantly surprised, however, to discover that after the dogs urinated on his treated fence, a brilliant fluorescent blue resulted. The chemicals in the urine had oxidized when they mixed with the coal tar. He named his brilliant blue Kymol.[82] In transforming valueless matter (waste from animals and machines) into a shiny new color, dead matter was magically gifted with a second life. Color's mysterious alchemy and unpredictable behavior prevailed, even at the height of the industrial age. Runge went on to write several textbooks about color and chemistry, including *Grundriss der Chemie* (1848) and *Zur Farben-Chemie* (1850), that offered useful information to artisans, printers, and housewives on topics ranging from how to produce certain colors to cleaning one's home using new industrial-produced synthetic chemicals.[83]

Stable synthetic colors, however, ones that could be used in dyes, textiles, and pigments, were not feasible until the mid-nineteenth century, after the innovative work of the British chemist William Henry Perkin. In 1856, at the age of eighteen, Perkin accidentally discovered the first synthetic purple while running experiments to synthesize quinine. His stable purple dye, first termed "Tyrian purple," and later mauve, or, mauvine, was quickly patented as the world's first semi-permanent aniline dye. But before Perkin could manufacture his color for mass industrial production, many factors intervened. For one thing, he went through lengthy and laborious processes of standardizing the chemistry and securing his business operations. His process involved using a solution of sulphate of aniline and a soluble bicarbonate in order to convert the sulphuric acid into a neutral sulphate. He then had to let this sit for ten to twelve hours, after which time it became a black powder solute. He then mixed this powder through a fine filter and washed it with water until it was free of the neutral sulphate. The next stage involved drying the substance at 100 degrees Celsius and digesting it with coal-tar naphtha. The residue from this evaporation process was then digested again with "methylated spirit," which "dissolve[d] out" the coloring matter.[84] While these chemical processes are likely foreign to most readers, my point is simply to indicate the lengthy and laborious process involved in industrializing early synthetic color.

Once standardized and prepared for mass production, Perkin's mauve appealed to diverse industries ranging from medicine, perfumery, food, explosives, photography, film, and textiles. However, he was not without competition. Other German, French, and British manufacturers quickly followed suit, including the rival South London firm of Simpson, Maule, and Nicholson; the Lyon schoolteacher François Emmanuel Verguin, who developed a brilliant formula for "solferino" red; German colorist Heinrich Caro, who, as scholar Regina Blaszczyk puts it, "mastered aniline chemistry in the calico mills of Manchester"; and the Bayer Company, founded in Barmen, Germany, in 1863 by Friedrich Bayer and Friedrich Weskott.[85] The European industrial revolution in synthetic color was under way, which eventually included hues like fuchsia, magenta, and brilliant yellows and greens (such as Naphthalimide Yellow, brilliant Sulfoflavine FF, and Azosol Yellow).[86]

By the end of the nineteenth century, new color textiles, garments, inks, dyes for fashion, and mass-produced oil paints in collapsible tube housing allowed painters (most notably the Impressionists) to skip the lengthy step of mixing paints in their studios and bring their premixed colors outdoors to paint landscapes and cultural life "*en plein air*." In lieu of these new mass-produced colors, Marcel Duchamp joked, any art made after the Industrial Revolution was already a "readymade."[87] Reinforcing this insight is the fact that before 1850, fewer than 50 dyes were known in the market, but by 1913 there were around 1,300.[88]

In the United States the industrial color revolution in dyes and pigments began in the 1920s and 1930s. The chemical industry's development of synthetic colors, Blaszczyk explains, gave way to a wealth of fast, cheap, and colorfast hues that rapidly transformed chemical, design, print, and fashion industries. This revolution also saw the advent of "color casting," a new field of industry experts who promised to predict the best-selling colors in the upcoming season. It is also important to point out that the rapidly emerging synthetic dye industry was subject to what chemical historian John J. Beer describes as the "whims" of fashion, with its changing tides and fluctuating demands. As a result, color developers were obliged to do two things to stay above ground: consistently increase the quality of the colors they produced and "find new colors to replace the old that were no longer profitable."[89] In many ways, the laws of supply and demand, complemented by growing competition, explain not only the shift in the local production of color to large chemical corporations, but also how synthetic colors, and later fluorescent colors, shifted throughout the twentieth century from novelty colorant to household and fashion norm. While very different circumstances affect the proliferation and development of digital postindustrial color, as I will show, color in both cases is hardly divorced from market and commercial interests.

In sum, on the one hand, the early production of synthetic fluorescents involved a curious process of transforming waste into brilliant color, taking its lead from the development of synthetic dyes. On the other hand, this process spoke directly to the laws of industrial capitalism and the logic of the commodity fetish. The laws of capital dictate that surplus value results from exploitation in the production process, whether this occurs through human labor or machines, or both. In the production process, labor is expended in developing an object or commodity, which is eventually equated with a "use value." Once the commodity is brought onto the market for sale, it competes with other commodities and its value then becomes relative to them, abstracted into an "exchange value." All goods and commodities (like the labor that went into them) are thus alienated from their origin, bearing instead a fetish appeal that only emerges through its marketability. As Karl Marx writes, "The mystical character of the commodity does not arise from its use-value." A commodity fetish like brilliant synthetic color is thus a social hieroglyph concealing its social and material conditions of production, whether in coal-tar waste, accident, or discarded debris. In this doubling capacity—as both a light and dark, valuable and valueless substance—the ambivalence of color once again rears its head.

The Switzer Brothers and Day-Glo

> Day-Glo fluorescent colors are like no other colors on the planet . . .
> We make them like this.
> —DayGlo Corp., *Designing with Day-Glo Color*

Through the work of the American-born brothers Joseph (Joe) and Robert (Bob) Switzer, synthetic fluorescent colors began to creep into mainstream U.S. culture in the 1930s and 1940s. The Switzers were originally from Montana but in 1931 they moved to Berkeley, California, where their father Emmet and mother Maud bought a pharmacy and Joe Switzer began producing amateur magic shows for his high school and church.[90] Meanwhile his brother Bob was attending the University of California at Berkeley on a scholarship and working at the local Safeway, a chain grocery store. After an unfortunate accident while unloading crates, Bob ended up in bed for months, confined to the Switzers' dark basement where he found his brother experimenting with a black light for his magic shows. Together they constructed their own ultraviolet lamp, which they used to search their father's drugstore at night. In the store, they discovered a yellow eyewash called Murine that emitted a luminescent yellow glow, which they used to produce a semi-permanent glow-in-the dark effect for their magic shows, including the illusion that the head of a Balinese dancer was being severed from her body, an effect that won them first prize at a magicians' convention in Oakland in 1934.[91] Also in 1934 they founded the Switzer Brothers Ultra Violet

Laboratories. Production headquarters were located in their family bathtub and mother's laundry room. Using an electric Mixmaster and kitchen utensils they developed dyes, resins, and shellacs that glowed under ultraviolet light.

In their early customer base were spiritualists who used their glow-in-the-dark paint to write messages on their customer's drapery, tricking them into believing it was a spirit communicating from the grave. In order to ensure the dramatic effect, the Switzers custom installed the colors and treated cheesecloth with luminescent paint to create the illusion of ectoplasm spiraling out of the spiritualist's mouth during the darkness of a séance.[92] Other early customers included morticians who, in preparing dead bodies for funerals, mixed fluorescent pigment with embalming fluid in order to determine when the solution had been "evenly distributed around the veins." Under ultraviolet light the treated corpse would glow, "as if radioactive," letting the mortician know he had conducted a successful treatment. In the 1940s the Switzers branded the embalming fluid Visibalm, jokingly dubbed "Granny-Glo."[93]

According to Bob Switzer, the Switzers also developed a money-marking system that played a key role in the tracking of the gangster John Dillinger.[94] Their fluorescents were involved in the preliminary detective work, used to make invisible fluorescent markings or "locator codes" that could track the clothing on laundered items of criminals. Even after several washings, the markings from their Fantom-Fast system were invisible in daylight but showed up under the black light. Chris Turner has recently suggested, however, that because Dillinger was "gunned down by the FBI on 22 July 1934," prior to launching the money-marking system, the story is likely apocryphal. Regardless of the Dillinger legend, the genius of the Switzer brothers' Fantom-Fast system was that it inscribed invisible and unknown markings inside recently laundered clothes items so that if an article of clothing was left at the scene of a crime, its owner could later be identified. Eventually sold to the Department of Justice, the system became obsolete once the detergent industry introduced fluorides in the 1940s. Also known as "optical brighteners," fluorides are powerful cleaning agents that would have washed out their invisible markings.[95] Optical brighteners, as one American advertisement proclaims, makes whites "whiter than white."

But given the severe limitations of light fastness in the Switzers' glow-in-the dark hues, they naturally wanted to create a more steadfast palette. They wanted colors that could glow in *daylight*. In 1935 Joe dipped some silk fabric into a boiling batch of alcohol and fluorescent dye and hung it out to dry. When he returned to his backyard he was surprised to find (similar to Runge's surprise when he returned to his backyard in 1833) the silk fabrics glowed brighter in the daylight than in the darkness. At first they didn't know the precise cause of the effect, but continued to produce and sell the colors regardless. For their first public application of the substance onto a Canadian billboard, they soaked

the board's fabric panels with a "combination of fluorescent orange dye and hot alcohol." They expected the color to fade quickly in the daylight but to their surprise the billboard remained a fiery orange that could be seen miles away. They named this first Day-Glo color Blaze Orange (figure 1.8).[96] Daylight fluorescents were born.

1.8

World War II offered a new testing ground for synthetic fluorescents. While the Japanese used the natural luminescent of cypridina (a bioluminescent species native to Japan) to guide them through New Guinea at night, the United States military turned to the Switzers' synthetic concoctions and spent $12 million on Day-Glo fabrics alone. The brothers engineered fluorescent products that illuminated signal panels to help pilots see runways at night; to mark Allied

troops so they could be identified as friends by Allied bombers; and as fire retardants used by aerial tankers to glow in the dark so as to identify where a plane needed to make a drop during a blackout.[97]

In Germany, the Nazis also manufactured a version of synthetic fluorescence—a radiolite paint developed from seashells and used to illuminate runways and dugouts and to mark tanks.[98] After fleeing Germany for England, the former Nazi scientist Olaf Nissen described how the Germans chemically cleaned the seashells. They heated them over a hot fire and, once the shells cooled, ground them into a fine powder then used to make a robust paint with a short period of fluorescence, although it could be renewed by a few hours' exposure to natural light, which naturally emits ultraviolet rays. The Nazis also found that when fluorescents were used to wash synthetic silk fabric, or rayon, the life of the fabric could be extended, as Bob Switzer also discovered. And thus the Nazis declared: "German housewives who still have artificial silk garments are being told by the war department how to make such an apparel last three times longer . . . This is necessary since there is no chance of replacing the silk once it is worn out." Nissen's documentation offers numerous, albeit eerie accounts of seemingly outrageous though apparently accurate Nazi developments like "Nazi officers make 'dead' Golf Balls alive with Syrup," "Rubber yields Synthetic Cocaine," and "Printing ink made from discarded cotton waste."[99]

Furthermore, during the Holocaust, bodies of the executed were exhumed for the sole purpose of collecting cadaver parts like hair, teeth, and nails to use as raw materials in the Nazis' production of synthetic materials.[100] As noted above, Germany's I.G. Farbenindustrie, then the world's largest chemical manufacturer and producer of synthetic films and dyes, used prisoners during the war to work in their Buna factory, also known as Monowitz-Buna and Auschwitz III, one of the three main camps in the Auschwitz concentration camp system in Poland, erected by the SS in 1942. The chemical transformation of death and dead matter into new forms of life is an ongoing theme in the history of color, whether synthetic, fluorescent, or otherwise. Here this metamorphosis gains a perverse and horrific twist. Even the Day-Glo Company, while declaring its fluorescents the official colors of "youth, action, and optimism," was producing pigments that contained large amounts of formaldehyde, a carcinogenic toxin that the Switzers' Ohio factory emitted into the atmosphere on a daily basis from 1934 through the early 1970s.[101]

Postwar Fluorescents and the Psychedelic Lifeworld

In postwar America, fluorescent colors took on meanings and associations linked more to mainstream consumerism, the counterculture and psychedelia. According to *Time* magazine, by 1951 the Day-Glorification of America had begun: "[A]dolescents wore fluorescent from coast to coast, as Switzer's

1.8 Day-Glo color, early palette. Courtesy of Day-Glo and Paul Switzer. A Registered Trademark of Day-Glo Color Corp., Cleveland, OH.

'Day-Glo' clothes became the newest fad."[102] Day-Glo appeared on billboards and on cigarette boxes. Prell shampoo, introduced by Procter & Gamble as a clear green liquid solution in 1947, was in 1955 given fluorescence and remarketed to women with the promise of making them feel "radiantly alive."[103] In 1955 Procter & Gamble also began selling Crest, the first toothpaste with fluoride. While fluorides had been added to the chemical composition of detergents since 1946, it was not until 1955 that Tide detergent was packaged nationally using Day-Glo colors on the exterior as well. The aggressive and eye-catching design on the front of the Tide carton, created by Procter & Gamble's art director Charlie Gerhardt, "appeared on supermarket shelves [as] a box [of] radiating concentric rings of vivid orange and yellow," complementing its powerful interior contents, an "ocean of suds." Tide proved to be a marketing success and within two years, the detergent aisles in grocery stores across the United States were filled with products housed in fluorescent packaging.[104]

As Blaszczyk notes, the veneer of conservatism often associated with the 1950s camouflaged a vibrant American commitment to personal freedom and individuality that eventually gave birth to the pop-and-sizzle of the 1960s. The heightened prosperity of the 1960s led to the increased industrial production and consumption of new kinds of bright and boldly colored goods.[105] Fluorescents herein segued from relative banality in beauty products like Crest and Prell into a position of greater cultural visibility that complemented the escalating energy of the new decade. Overall, the sixties were a turbulent decade in terms of politics, civil rights, feminism, and emerging subcultures like the predominantly California-based "counterculture," which embraced a freewheeling, psychedelic lifestyle.[106]

A linchpin in the counterculture's new world of psychic experience was the consumption of LSD, or lysergic acid diethylamide, which was unregulated in California until 1965. Like other hallucinogenic drugs, LSD intensifies sensory experiences, especially the visual sensation of color. If fluorescent colors—without LSD—stimulate the nervous system more directly and intensely then normal colors, then on LSD the sensory effect of fluorescents is even further amplified. To put it differently, if fluorescent colors sizzle under normal viewing conditions, on LSD they explode.[107]

In the hands of Ken Kesey and the Merry Pranksters, as recounted in Tom Wolfe's 1968 *The Electric Kool-Aid Acid Test*, LSD became a recreational drug. After signing up for a CIA-sponsored research project into the effects of psychoactive drugs at the Menlo Park Veterans Administration Hospital, where he was working as a night aide, Kesey returned to his peers to spread news of his experiences with LSD, mescaline, and IT-290.[108] Kesey and the Pranksters traveled along the west coast in their Day-Glo-colored bus named FURTHUR, painted inside and out with bright spectral colors.[109] The goal was to freak people out, at first with wild psychedelic colors and later with LSD: the "destroyer

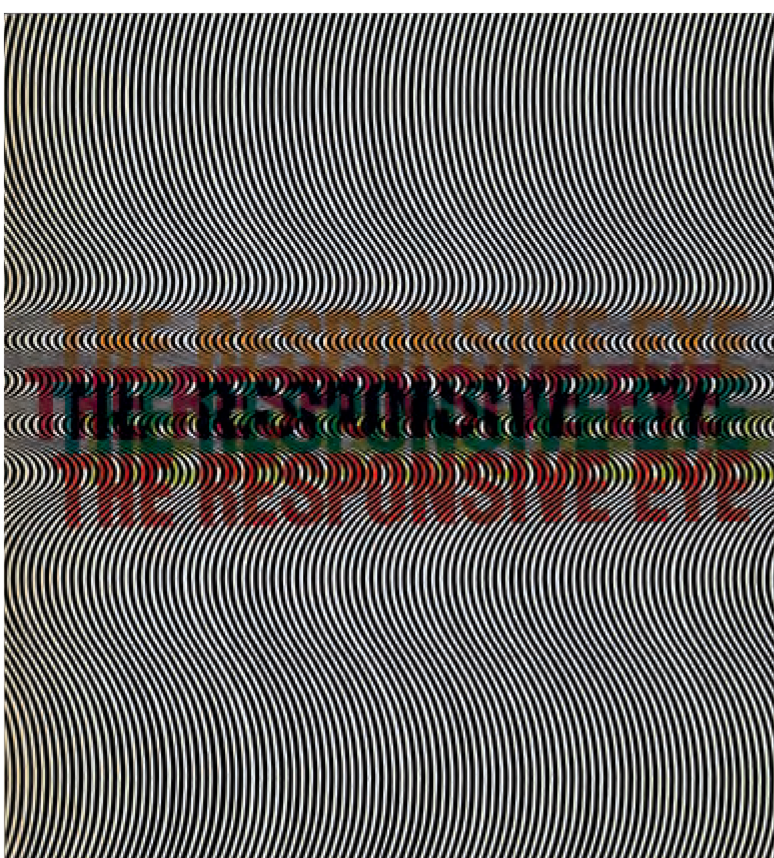
of tidy psychic worlds," as Todd Gitlin puts it.[110] In full Day-Glo regalia, Kesey arrived at the antiwar sit-ins on the Berkeley campus in October 1965 when he and the Pranksters began to sponsor several public "acid tests" throughout California where people came together to collectively trip on the psychedelics. 1.9

These acid tests paralleled the explosion of colorful and visionary multimedia events and "happenings" throughout the 1960s: the Company of US (USCO) multimedia productions, Experiments in Art and Technology (EAT), Joshua Light Show (figure 1.9), Andy Warhol's *Exploding Plastic Inevitable*, the Grateful Dead, acid-rock light shows, California Light and Space and Finish Fetish movements, Modern Art spectacles, Light Art, Neon Art, and filmmakers like Jean-Luc Godard, Paul Sharits, Michelangelo Antonioni, and Terrence Malick who explored new forms of cinematic expression through highly stylized uses of color.[111] Media artists like Nam June Paik produced the psychedelic-looking *TV Magnet* in 1965 and in the same year, the Museum of Modern Art in New York hosted the first major American debut of op art in the popular exhibition *The Responsive Eye* (figure 1.10).[112] Just before this, in 1960, French artist Yves Klein patented his own synthetic color: International Klein Blue (IKB), an artificial ultramarine blue pigment mixed with "a binder, a polyvinyl acetate formulated by Rhone-Poulenc Industries," which he distributed under the name Rhodapoas M: patent no. 63471.[113] And yet, as candid as he was about its artificial nature, Klein nonetheless seemed to relapse into a kind of neoromanticism arguing that, when alone with the color, he was at "one with the universe." "Through colour," he wrote, "I experience a complete identification with space. I am totally free."[114]

1.9 The Joshua Light Show performing behind Frank Zappa and the Mothers of Invention, Mineola Theater Center, New York, December 1967. Colorful psychedelic lights complement the eccentric music. Courtesy of the Joshua Light Show.

In the world of 1960s fashion, Day-Glo hues were also steadily moving from novelty to norm. Italian fashion designer Emilio Pucci, known for his bold and colorful designs, was commissioned to create the uniforms for the flight attendants on Britain's Braniff Airlines, as part of its campaign to "End the Plain Plane" (figure 1.11). Braniff hired Italian designer Alexander Girard to decorate the jets in multicolored pastel hues, which he did in lemon, lavender, and dark metallic purple. Braniff's logo featured a Day-Glo dove called the "Bluebird of Happiness."[115] Flight attendants moved about the cabin in Pucci couture, from stockings to miniskirts, silk scarves, and absurd transparent space-age helmets (called "space bubbles" and "rain domes") designed to protect the wearer from the rain.

In 1968 Maidenform sold matching Day-Glo underwear sets as a part of its Sea Dream Collection (active from 1922 to 1997). The new Day-Glo line was advertised by two models wearing face paint and underwear that glowed in the dark (figure 1.12). Also in 1968, then-emerging fashion designer Betsey Johnson, who had been experimenting with fluorescent fashions, exclaimed, "My clothes are for young people who are saying, 'Look at me I'm alive.'"[116] It



1.10

was also 1968 when the Switzer brothers officially founded their Day-Glo Corporation in Cleveland, Ohio, where they manufactured "daylight" fluorescent pigments and dyes for fashion houses, art retailers, and textile businesses. 1.11

By the late sixties, daylight fluorescent colors could be found just as much in the interiors of hip homes, coffeehouses, and communes in countercultural communities on the West Coast as in the mainstream. Daylight fluorescents appeared in colored paints, pencils, and such children's toys as Hula Hoops, Frisbees, and Big Wheels. American highways were lined with blaze orange traffic cones and safety signage.[117] Day-Glo outfits were worn by the Beatles on the cover their album, *Sgt. Pepper's Lonely Hearts Club Band* (1967) and Day-Glo artwork graced the cover of Black Sabbath's second album, *Paranoid* (1970). By the seventies, psychedelic hues went hand-in-hand with edgy electrified music. Bold pink and yellow-green Day-Glo screamed on the cover of the Sex Pistols' 1977 album, *Never Mind The Bollocks*, thereafter linking punk rock to Day-Glo, followed up with the jacket of X-Ray Spex's *Germfree Adolescents* (1978), inside of which was a bright orange vinyl record that contained a track entitled "The Day the World Turned Day-Glo."[118]

< **1.10** William Seitz, *The Responsive Eye*, 1965. Catalog cover for the exhibition held at the Museum of Modern Art, New York February 25–April 25, 1965. The background image features op artist Bridget Riley's 1964 *Current*. Printed by the Case-Hoyt Corp., Rochester, New York.

1.11 Emilio Pucci's fashion designs for Braniff Airline hostesses, 1965. Photographed outside the Paris Concord. Courtesy of the History of Aviation Collection, Special Collections Department, McDermott Library, The University of Texas at Dallas.

1.12

Music posters designed by graphic artists like Victor Vasarely and Peter Max lined Haight Street in San Francisco, bursting forth in Day-Glo hues. Max, for his part, had developed a new technique for fluorescent colors and Day-Glo printing that emphasized their mystical and transcendental attributes. Just as Henri de Toulouse-Lautrec had "captured the imagination of 19th century Paris" with the colorful theatrics and elegance of Parisian life, color theorist Charles Riley argues, "Max led the international youth movement of the 1960s into a new visual culture" of intricate and detailed coloration that still exceeds what computers are capable of doing today.[119]

And yet, all of these bright and magical hues strewn across the cultural landscape were not without a dark side. By 1968, the psychedelic colors that filled discos, funhouses, and lined Haight Street and St. Mark's place in the East

Village, had also come to embody a common darkness marked by death, drugs, self-destruction, and cultural dropouts. In the press—from *Time* magazine to the *New York Times*—pages were filled with warning signs of the dangers of LSD and the radical cultural practices that went with it. One "dropping" event (a term used to describe the use of Fulleresque geodesic domes) in Dallas in 1966 was titled "Armageddon—The Dooomsday Gig," advertised in Day-Glo colored posters. A new emptiness and end to the once progressive sixties was sensed inside and out.[120] In stark contrast to Max's optimistic colors, Andy Warhol used bright fluorescents to signify this darker side of postwar culture and American consumerism.[121] Already in September of 1963, Warhol had announced the title of his upcoming show: "Death in America." Three months later, President John F. Kennedy was assassinated.

Synthetic Color in Postwar Media

New media technologies further amplified the postwar frenzy for luminous synthetic hues. While synthetic color first appeared in Technicolor and Agfacolor in the 1930s and 1940s, it did not become common in the moving image until the 1960s, when Eastman Kodak released a series of color film stocks equipped with a prestripped magnetic soundtrack that allowed black-and-white cameras and magnetic sound equipment to be used with color. The stock was meant to function quickly and easily, without the elaborate processing and precision optics required with Technicolor. Once a stable and easy-to-use stock was in use in 1967, the film industry cut black-and-white production to the lowest levels in film history and within three years, black-and-white film had become so rare only infrequent documentaries used it.

Markedly synthetic color began to appear in art photography through the work of American photographer William Eggleston. Between 1965 and 1969, Eggleston appropriated the highly saturated dye-transfer methods used in the advertising industry. In his *Woman on Swing*, for instance, an elderly woman sits on a patterned bench outdoors. The camera sees her directly and starkly. She is old and frail but the rich colors of the floral print on her dress and the cushion that she sits on pop and sizzle, imbuing her and the image with a synthetic vitality. Through color, the image rides the threshold between the mundane and the spectacular, the essence of postwar American life.

The advent of color television marked an equally dramatic turning point in postwar culture (figure 1.13). While color television sets first became available to consumers in 1954 (models were offered by Admiral, Westinghouse, and RCA) it was not until 1965 that broadcast television, beginning with NBC's *Newsreel*, switched the majority of its content to color. The rush to color was so great it resulted in a "processing bottleneck" reminiscent of Technicolor's shift to color in the 1930s.[122] By the late 1960s, color television became a medium

1.12 In 1968 Maidenform released their glow-in-the-dark Day-Glo underwear set as a part of its "Sea Dream Collection."

1.13 of the present—of current affairs and news reports, as Richard Misek points out, and black-and-white, by default, became a medium of the past.[123] (In the next chapter I will expand on the history of early color television.)

By the end of the 1960s, American film, photography, and television industries had achieved a new index of realism in synthetic color.[124] Whether chemical or electronic, synthetic color had become the unabashed icon of commodity culture and the new age of electronic media. The more saturated and hyper-real the hue, the more accurately and authentically did it reflect postwar American life as it was actually lived.

This chapter has provided an overview of color studies, from its origins in Western aesthetics, through industrialized synthetic fluorescents and Day-Glo. The following chapters analyze synthetic electronic color in analog and digital computing after 1960, beginning with the highly innovative color experiments in analog video synthesis circa 1969.

1.13 RCA's CT-100, 1954: The first color television set marketed to consumers, offering low-quality color at a high price. Photograph courtesy of Kris Trexler.

Chapter Two
Synthetic Color in Video Synthesis

[With] television . . . you're on the way to being a starchild . . . inner and outer space become one in unknown velocities of a cosmic zoom . . . the now indigo blue of life merge with the glowing beauty of man at his most human.

—Ron Hays, 1971[1]

[T]elevision is a psychic healing medium creating mass cosmic consciousness, awakening higher levels of the mind, bringing awareness of the soul.

—Eric Siegel, 1970[2]

In 1969, electronics engineer Eric Siegel asked, "After a trying day, why can't the viewer . . . sit down at his TV set and listen to music while watching the screen burst with beautiful colorful displays?" These "visual phantasies," he explained, "would relax you better than any tranquillizer and at the same time give your spirit a wonderful lift . . . working through your audio-visual senses into your mind and soul."[3] Siegel was by no means alone. In 1970 Gene Youngblood wrote, "Television will help us become more human. It will lead us closer to ourselves."[4] In their 1973 article, "A Color Video Collaborative Process," pioneering video artists Dan Sandin, Jim Wiseman, and Philip Lee Morton wrote, "[C]entral to our experience . . . is the use of high technology as an adjunct to personal and spiritual growth."[5] Today these attitudes seem less optimistic and visionary than they do deluded, absurd even. Contemporary television viewers—consumers rather—know full well that the medium is commercially driven; seeped in fear-based content dealing in war, crime, scandal, horror, voyeurism, and atrocity occurring on global and local scales, twenty-four hours a day, seven days a week, punctuated only by brief commercials attempting to sell you impossible fantasies. In the twenty-first century, television couldn't be further from the "soulful" embrace of the "glowing beauty of man at his most human." But given the not so distant past of these views, and their sheer abundance, one wonders how such mystical notions of television ever seemed logical, let alone normative. How did a group of technically minded artists in collaboration with engineers immerse themselves in sophisticated and challenging technological environments only to produce an entire genre of work that casts aside dense technical realities to depict instead a transcendental and spiritual, mystical beyond?[6]

To answer this, this chapter provides an aesthetic analysis of analog electronic color in video synthesis circa 1969. I begin with a brief overview of the development of color in television history. I next distinguish television from video art and analyze two analog color synthesizers developed by electronics engineer Eric Siegel between 1968 and 1970. I then discuss the innovative video synthesizers developed by California-based engineer Stephen Beck and, in the second part of the chapter, Nam June Paik and Shuya Abe's Paik-Abe Video Synthesizer and the context it was produced in at WGBH in 1969, under the guidance of visionary directors Fred Barzyk and David Atwood.[7] As a segue from the analog to the digital, I close the chapter with an analysis of the Scanimate, one of the last analog video computer systems used to produce supersmooth liquid rainbow effects for the television and film industries in the late 1970s and early 1980s.

In order to produce color and manipulate images in computing in the 1960s, this chapter shows how one often had to build the technical system and learn programming or engineering in a way that contemporary users do not (users today can just purchase the software or follow a set of instructions)

and further, one had to then make these technical and engineering concepts intuitive. That is, one had to transform complexity into intuition and habit. To demonstrate the significance of this challenge, I link the chapter's technological milieu with the then prevalent notions of mystical "transcendence," which I read through Graham Harman's idiosyncratic reading of Martin Heidegger's 1927 tool analysis. By connecting the techno-ontological and cultural-historical dimensions of video synthesis, the chapter offers three rationales as to *how* these highly technical practices became intuitive and ultimately seeped in transcendentalism in a way that contemporary digital colorism is not. The "electric now indigo blue," the chapter concludes, is no doubt mystical but it is also very much grounded in existential—cultural, technical, and historical—fact.

Finally, the chapter focuses on color in *analog* electronic computing. In contrast to the digital, analog electronic computers operate through analogy. In analog electronic computing, data is transferred through a machine, from input to output, in a *continuous* form. An analog computer takes a quantity from a physical source like an electric current or sound and abstracts it into a corresponding value that is directly representative of the input, such as a sound wave or X-ray. In contrast, digital computers are fundamentally arithmetic and operate through a rigorous quantization of *discrete* numerical values, often in binary form. As James Small describes it, the difference between an analog and digital computer can be compared to the difference between the slide rule and the abacus. He writes:

> In the abacus, quantities are represented by a number of beads, thus the quantity being represented can only vary, up or down, by a minimum of one bead—there are no partial beads . . . .all operations are performed as a series of additions or subtractions. In contrast, the slide rule represents quantities as continuously varying magnitudes: in this case length. The granularity of the result is limited only by the coarseness of the scale used to perform the measurement.[8]

The digital operates through discrete numeric calculation while the analog operates through continuous relation. As Lev Manovich puts it, with analog media, "the axis or dimension that is measured has no apparent indivisible unit from which it is composed."[9]

The shift from analog to digital computer graphics marks a significant pivot in the material and aesthetic history of new media art. After the digital turn, which occurs throughout part 2, images must be understood in terms of *simulation* and *transcoding*; a necessary movement *between* two different systems, languages, or registers, such as the algorithm to the interface. In chapter 6, I analyze the epistemological and ontological problems that this fundamental and irreparable gap introduces into contemporary aesthetics and imaging techniques. For now, I venture into the world of early analog computing in visual art.

Electric Global Village, circa 1969

As the earthship embarked on a new age of networked global relations and cybernetic exchanges, the soft and luminous glow of the television became its universal mascot. On July 20, 1969, we all traveled to the moon through our television sets ("we" being Western culture, broadly speaking). We looked at our planet and ourselves for the first time from the point of view of the moon. The event signified nothing less than a reconfiguration of what it meant to be human. Through real-time televised feedback circuits, objectivity was eradicated and we ceased to know ourselves as autonomous individuals, linked only through an anonymous, spiritual, electro-cybernetic embrace. In the feedback circuit of the earth-moon ship, Youngblood wrote, humanity's "total brain-eye" extended out "around the moon and back."[10] "One small step for man, one giant step for mankind." On this day, the logic of electronic computing and cybernetics merged with mainstream culture and with it an affirmation that, armed with the new electronic technology, humanity could transcend the limits of time, space, and culture.

Marshall McLuhan's then popular dictum "the medium is the message" appealed to many as prophecy. This formalist-driven adage denotes the ways in which the material and technical plat*form* of an image, such as a canvas, a screen, or a monitor, always takes precedence over the semiotic meaning or "content" of the image. Whether one watches screen static or news footage of the war in Vietnam is irrelevant. What counts is the medium and our physiological relation to it. What then is the message of television? When one watches television, in McLuhan's account, one is enveloped in a narcissistic trance; a cybernetic feedback loop where individual cognition is "amputated" in exchange for an audio-visual sensory experience of looped-belonging in a cool electronic glow.[11] The message of television *is* its ongoing flow; its rapid scans and constant, nonstop movement of information, which, after the turn to color in the late 1960s, only intensified. Circa 1969, color television became so utterly of the moment—so much the essence of now-ness—that for many, it transcended even itself.

A Brief History of Color Television

Color TV can be ghastly.
—Howard Ketcham, 1968

As I discussed in chapter 1, color is unruly and every new technology faces a unique set of challenges in the effort to standardize it. The history of color television could not illustrate this more clearly, while also showing how TV broadcast consistently outstrips concern for color or image quality. For instance, in January 1972, Nam June Paik presciently wrote:

> We are hearing so much about "Broadcast standard" in video. But the more important the content is, the technical standard tends to be less perfect . . . eg. CBS report on the dissenters in Soviet . . . and many satellite relays, which tend to lose color sync often . . . and finally MOON LANDING. Moon landing's picture was way below the FCC standard. Why did FCC not forbid the broadcasting of Moon landing? . . . it was a double standard. Moon landing killed so-said FCC standard in video-technology for good.[12]

Paik is right on target, forecasting the widespread acceptance of low-resolution video now pervasive on the Internet (a theme I return to throughout part 3). Nonetheless, it is worthwhile taking a brief segue into the contested history of color television standards, with an eye turned towards color consistency.

Color television was first developed as a phosphor-based technology that relied on earlier developments in vacuum tubes from the 1850s and cathode rays from the 1870s, which together allowed for a system where electrically charged phosphors could be organized and displayed visually, at first using a Braun tube, on the surface of screen. Engineer Vladimir Zworkyn, after having fled the Russian Revolution, first envisioned the idea of color television while working at Westinghouse and RCA laboratories in the United States in the 1920s. However, the concept did not materialize until 1928, when Scottish engineer John Logie Baird experimented with and demonstrated a method of "sequential color analysis" using a mechanical television system that later inspired Hungarian television engineer Peter Goldmark's "field-sequential color system" for CBS in 1950. Early color systems used Nipkow or Benham disks, colored disks with small holes punctured in them and placed in between the screen and the black-and-white monochrome broadcast signal so that when they rotated inside the display device, usually at 1440 rpm, they would generate colored scan lines.[13] Positioned on the other side of the screen, a viewer would see a partially colored image.

In these early years, producing color television was highly unstable, imprecise, and inconsistent. Throughout the 1930s and 1940s various techniques were developed to achieve greater precision and accuracy for color television, but in order to be suitable for broadcast, which became the real challenge in the 1950s and 1960s, color information had to be standardized and compressed. Because the consumer market was already saturated with black-and-white television sets, it was not until after the color television signal could consistently reproduce black-and-white broadcast signals with it that engineers from thirty electrical companies founded the NTSC, or, National Television Systems Committee, a subgroup of the Electronics Industries Association (EIA). After 1954, the Federal Communications Commission (FCC), a central government agency, endorsed the NTSC color scheme as the standard for broadcast color.[14] All color signals, or "chrominance signals," henceforth needed to be compressed and regulated through a vectorscope, an electronic

radar-like device used to monitor the frequency and wavelength of color signals for broadcast standards.[15]

While the development of a color standard for television was considered a tremendous peacetime accomplishment in the United States, as Jonathan Sterne and Dylan Mulvin point out, establishing this standard was more of a *compromise* than an achievement in high-definition technics. Color television did not add greater "depth or meaning," but to the contrary, the newly standardized color television actively *reduced* the color gamut to the most minimally acceptable range. Borrowing from Fechner's psychophysical research into the "just noticeable difference," discussed in chapter 1, television engineers argued that the "normal" eye of a so-called standard observer had a lower acuity for blue waves and thus the NTSC color standard developed towards the blue end, with additional transmission tending towards the lowest possible values of green and red.[16] In other words, according to the law of just noticeable difference, the eye is less able to detect minor differences in line or detail in bluish images, and thus, lower bandwidth bluish images could be broadcast with less people noticing a difference.

Part of the drive to radically compress color bandwidth was, as noted, due to the fact that the color television signal *had* to fit into a predetermined bandwidth of six megahertz and remain compatible with monochrome signals.[17] But more significantly, the effect of this radical signal compression fortifies McLuhan's prophetic claim that television is a "cool" medium. This is true for several reasons, three of which I note here. First, blue is a "cool" color. Second, television's low-resolution image requires viewers to "fill in" the details in the dot-sequential or scan-rendering system. And third, additive color systems demand a more active kind of perceptual experience. For McLuhan, the more one participated and was "drawn in" to the image, the more one was hypnotized into a cool, auto-amputated, narcissistic trance.[18] As he put it in 1964: "a hot medium is one that extends a single sense in 'high definition' [like radio, whereas with a cool medium] "so little is given and so much has to be filled in."[19] I will return to McLuhan's theory of hot and cold media below and in chapters 5 through 7.[20]

December 1953 marked the advent of the first marginally successful color broadcast system, eventually pioneered on a large scale in Chicago in 1956 and used in the United States until 2009 when the new digital television standards surpassed it.[21] The first color television sets were made available to consumers in 1954. Models were offered by Admiral, Westinghouse, and RCA, and cost between $1000 and $1200. NTSC had become big business but the problem, as television historians have pointed out, was that the NTSC standard was "oriented more towards economic profit than technical feasibility," and thus what could have been a fuller and richer color palette was reduced to the lowest common denominator. Such standardization should of course be expected

for a new color technology, that is, if one desires it to be functional, useful, and adopted on a mass scale. But one also wonders about the colors cast aside, not to mention the fact that even *with* this new standard, NTSC still had problems yielding consistent colors, evidenced by the fact that in the early years the organization was informally dubbed "Never The Same Color," or, according to Sterne and Mulvin, "No True Skin Color."[22]

Howard Ketcham, color consultant for several large manufacturers and one of the men responsible for setting the standards for broadcast color, noted, "The electronic processes peculiar to color TV do some highly irregular things." These "danger areas," he continued, demand a great deal of consideration, for example, how to control the way "red bleeds into other colors especially whiter, neutral areas. White[s] often looks bluish or yellowish . . . pale pastels have a tendency to fade and appear almost colorless . . . [and] deep reds sometimes loose character and appear brownish."[23] For years these liquid and ephemeral televisual colors acted as antagonists to any attempt at standardization and control. One needed a Michel Eugène Chevreul for color television, but no such figure appeared.

Advertising revenue—the industry's main support for color—was threatened when color TV proved incapable of representing a companies' products (often food) in a desirable light. Without color consistency, Karal Ann Marling notes, good food could very easily look very bad.[24] The situation devastated the industry, which not only wanted to please its financial investors by showing its products in an attractive light but also wanted to market color television as a form of realism, especially for news and drama programs. Studios spent endless hours adjusting lighting, costumes, and makeup in the attempt to depict "natural" skin colors, wardrobes, and settings but color remained unmanageable. In the early years, getting accurate color on TV, Ketcham explains, was like washing colors in warm water: "fabric colors whirl around in TV's electronic environment and come out changed."[25] Those who lived through the transition to color may recall the dramatic differences in color reception on different models and makes of televisions, forcing home viewers to become "interactive" viewers, as one would say today. Cinema and media scholar Dana Polan recalls the obvious artificiality of color of TV at the time when, as a child, he would have fun making a human purple by twisting the knobs on the receiver that had been carefully adjusted by an adult.[26]

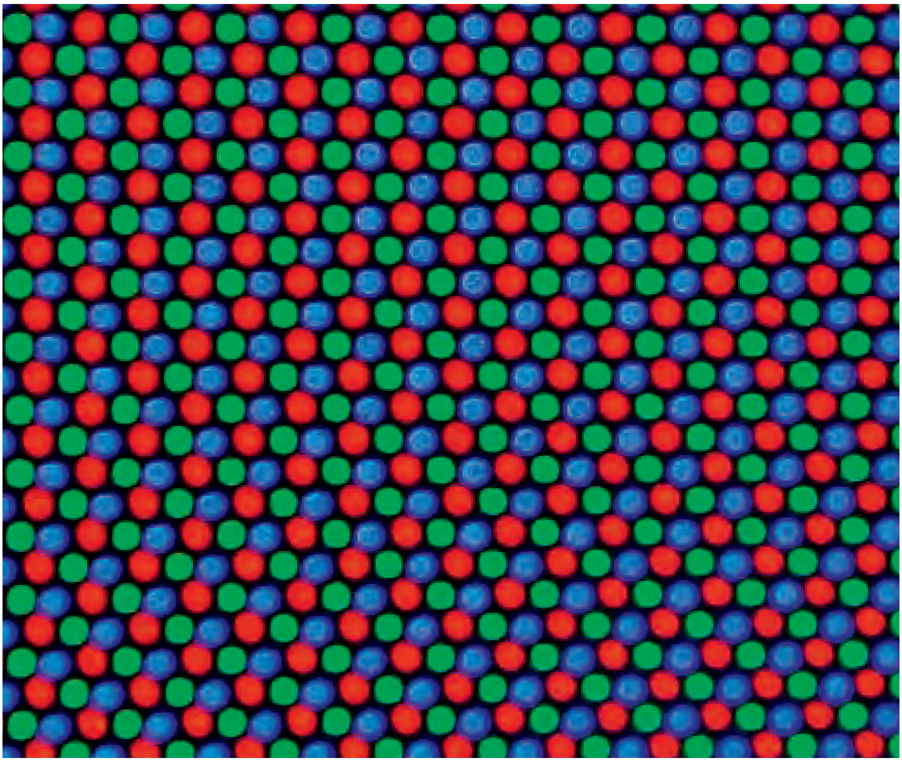
Due to political complications with RCA and the FCC, color television, which had made an initial debut in the early 1950s, as noted above, was forced to retreat until appearing again in the mid-1960s. By 1965, only one half-hour of programming on the three major networks (ABC, NBC, and CBS) remained when viewers did not have at least one color program to watch, and by 1966 almost all programming was in color.[27] Once in full color, television was accepted as a "medium of the present"—of news programs and current affairs—where

black and white, by default, "became a medium of the past."[28] By the end of the 1960s, color TV had achieved a new index of realism, marking, Perry Anderson argues, the "single technological watershed of the postmodern."[29]

While color television became vernacular in the 1960s, seemingly lost in this process were the colors cast out of the newly compressed standard coupled with a lack of appreciation for the materiality of the colors themselves. Television systems, as noted in the introduction, are additive, which is to say two things. First, the colors seen "on" screen *do not actually exist in the screen or fixed in the electronic signal*. In other words, in color television, the color no longer holds any immediate or direct reference to itself. Unlike a strip of film, which is subtractive and pigment-based, a video signal is actually colorless and invisible.[30] Video information is coded into electronic signals but the "color" does not exist until rendering or scanning, which is also when additive color mixing occurs in subjective perception.

Second, a colored TV image *occurs* through the act of watching TV. The multicolored images are ephemeral; they exist in the subjective perception of each viewer. When viewed close up, a color CRT screen reveals a matrix of tiny red, green, and blue *dots*, or *trace points*, which, like an Impressionist painting, form an "image" only when one steps back and takes in the whole (figure 2.1).[31] Given that this so-called "image" is only a series of rapid electronic scans, any "whole" can only be partial and ephemeral. In this sense, televisual color is all code; not yet a *digital* code, but analog code modulated in continuous wavelengths and regulated through vectorscopes shot through phosphor guns onscreen. This is a crucial point because it marks the first step in the book's larger argument for a paradigm shift from optical and visual epistemology into what I term the post-optic, algorithmic lifeworld, which I go into further detail about in chapter 6.

Additive color systems are central to modern screen technologies, including LCD (liquid crystal display) and DLP (digital light processing) systems, which include LED systems.[32] In a digital LCD, for instance, a prism splits the light from a projector bulb in three ways and each beam of polarized light is sent through one of three LCD panels that corresponds to either the red, green, or blue component of the video signal. The pixels on the surface of each of these panels open or close to allow the relative amount of light to pass through at each point in the image and the resultant RGB values are recombined or "sandwiched" as they are cast onto the surface of the screen.[33] When viewed up close an LCD image is similar but distinct from a CRT, consisting of millions of tiny RGB *rectangles*, also organized in a grid formation, that form a second picture when viewed from a distance. Both systems derive from Cartesian grid-logic, marking yet another step in modernity's long history of the "mathematization of color," as Sean Cubitt puts it, which began with Newton. But unlike CRT screen systems, which rely on electroluminescent phosphors for their



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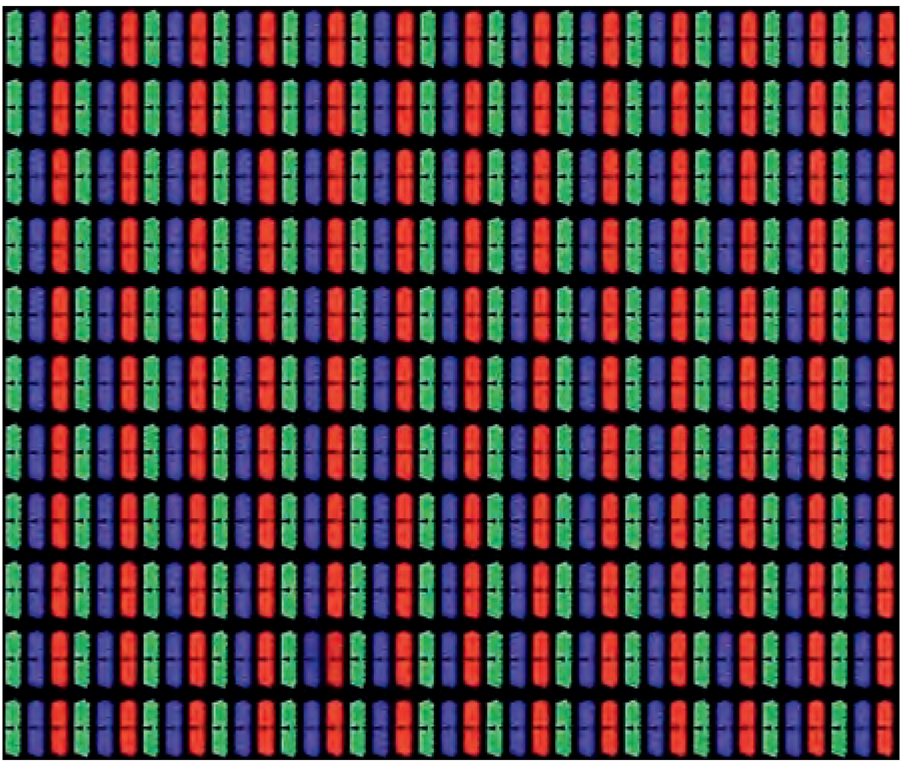


2.1b

illumination, LCD screen technologies contain a narrower color gamut and employ instead mercury-vapor fluorescent backlights, which also involve lower energy demands that, as I will argue at the end of this chapter, lead to a "colder" and "flat" digital aesthetic.[34] In sum, these material-technical and physiological dimensions of color television reinforce the fact that tele-vision is a cybernetic *system*; instantiated through human-machine feedback loops that fuse particular kinds of signal processing with subjective perception. For reasons I will now address, the first generation of creative video synthesis remained largely focused on these subjective and phenomenal aspects of televisual perception.[35]

Video Synthesis

"VT is not TV," Gene Youngblood wrote in 1970. TV deals with stories, dramas, fiction, news, and sit-coms, whereas VT—videotape and video art—is concerned with the medium or what happens to the medium once it is placed in the hands of artists. Granted many early video artists produced work that was broadcast on TV or played off of and referenced the conventions of television, Youngblood's distinction between VT and TV helps us to identify how the emerging medium was used early on in formal aesthetic experiments, ones not without socially and politically progressive purposes. To put it another way: VT and TV are the same *technologically*; their difference lies in *application and use*. "Video Art," Ron Hays explained in the late 1960s, "has to do with discovering ways to use (and finding uses for) moving image configurations that are produced with the same electronics responsible for the transmission of everyday everyman television pictures" but unlike broadcast commercial television, he continues, "video art wants to develop the artistic potential of the television screen itself."[36] This artistic potential of the screen "itself," is also to say the materiality of the televisual system, the essence of which is the video signal. A subgenre of VT, termed "video synthesis"—the subject of the remainder of this chapter—is one of the strongest approaches to realizing this "potential" given that creative work in video synthesis tends to be overwhelmingly abstract, colorful, and psychedelic.

Video synthesizers derive from earlier developments in audio synthesis, associated with the history of electronic music, as I briefly note in chapter 4. However, working with video synthesis is technically more complex than audio synthesis because video signals cover a frequency spectrum 100 times as broad as audio signals do. Second, video signals must be constructed and modulated according to a precise synchronization in order "for a viewable picture to emerge." For this reason, video theorist Jeffrey Siedler explains, the development of video synthesizers took longer to emerge than their audio counterparts.[37]

2.1 (a) Close-up of the phosphor coating on an analog cathode ray tube (CRT) television screen. (b) In contrast, when one views a liquid crystal display (LCD) close up, one sees rectangular bars instead of dots.

German artist Karl Otto Götz envisioned art with video synthesis as early as 1959, when he observed that electronic images were generated productively, versus reproductively. That is, the video image is created in the circuit ex nihilo. In this way, the new electronic image suggests an ontology wholly distinct from that of older optical media like film and photography. TV and VT, like computer media, generate images as *effects of signal processing*, whether in a discrete (digital) or continuous (analog) fashion. This is why television, video, and computer media are *not visual media* but rather post-optic, electronic media. It is also why color in post-optic, electronic media is, on a material level, primarily concerned with code, signals, and algorithms and only second with visual expression.

Because I cannot go into detail about all of the experimental and highly innovative video synthesis devices produced in this period, I provide a brief overview before focusing on key abstract color experiments with video synthesizers developed by Eric Siegel, Nam June Paik, and Stephen Beck.

In his 1976 article "Image Processing and Video Synthesis," pioneering video artist Stephen Beck classified video synthesizers into four basic types. The first were "camera image processors," colorizers capable of modifying or adding chrominance to a monochrome signal. This included Siegel's first synthesizer, the Process Chrominance Synthesizer, and pioneer Dan Sandin's 1973 analog Image Processor, an open-source patch-programmable computer for processing video images in real time. In collaboration with Tom DeFanti, Sandin's system eventually integrated real-time computer graphics to produce visual concerts or "Electronic Visualization Events." The system was replicated by a number of artists at the time, including Phil Morton, who used it in his ethereal *Colorful Colorado* (1976). Its popularity was in part due its open-source philosophy, complemented by Sandin's "distribution religion," which advocated artists "roll your own" synthesizer and "use High-Tek machines for personal, aesthetic, religious, intuitive, comprehensive, [and] exploratory growth."[38] (In many ways his open-module system encouraged precisely this, as I discovered when experimenting with a Sandin Image Processor while in residency at the Experimental Television Center in 2008.)

The 1972–73 "Rutt / Etra Video Synthesizer" occasionally referred to as the "Rutt / Etra Scan Processor" also belonged to Beck's first category. This system was an analog computer engineered for video raster manipulation, built by Steve Rutt and Bill Etra and it could electronically modify a video image to generate a new TV grid or electromagnetic matrix. The Rutt / Etra Scan Processor was used by pioneering video artists Steina and Woody Vasulka in *C-Trend* (1974), *Reminiscence* (1974), *Vocabulary* (1973), *Violin Power* (1970–78), *The Matter* (1974), *The Art of Memory* (1987), and *Voice Windows* (1986).[39] And while much has already been written on the important work of the Vasulkas, they should at least be noted here.

The couple produced work together and independently from the 1960s through the 1990s.[40] Peter Weibel sings the praises of Woody Vasulka when he writes, “What Olafur Eliasson achieves today for the analog world of light, Woody Vasulka did for the digital world of light some time ago.”[41] Woody Vasulka worked with “diffractive optics” and the “curvature of the waveform,” Weibel argues, in a way distinct from his peers, who “operate[d] with retinal effects using scientific insights of the nineteenth century.”[42] This may be true, but it is also the case that these “peers” were equally concerned with the material technics of the signal, at least initially, as I demonstrate here.

Beck’s second group of synthesizers were direct video synthesizers, capable of generating their own video signal and image without an external input. Examples include Eric Siegel’s EVS and Stephen Beck’s Beck Direct Video Synthesizer (discussed below), the EMS Spectron, and the Supernova 12. The third type was the scan modulation / rescan synthesizer, which used the principles of scan modulation to alter the geometry of the image on a screen. This class of synthesizers also included the Paik-Abe Video Synthesizer (PAVS 1969), a colorizer most often attached to a scan modulator, capable of generating its own images as well as receiving an image from an external source.[43] The fourth type was the non-VTR recordable, an oddball that included prepared television sets that could display, but not record, distorted images. The obvious example here is Nam June Paik’s *Magnet TV* (1965), as well as Bill Hearn’s Vidium, an electronic image-generating instrument developed in 1969 at the Lawrence Berkeley Laboratory, and the Tadlock Archetron. As Siedler puts it, most of these synthesizers were based on the “principle of magnetic distortion using the color picture tube as if it were an oscilloscope screen.”[44] That is, color was used in terms of its particular affinity to the screen-scan, not to signified content.

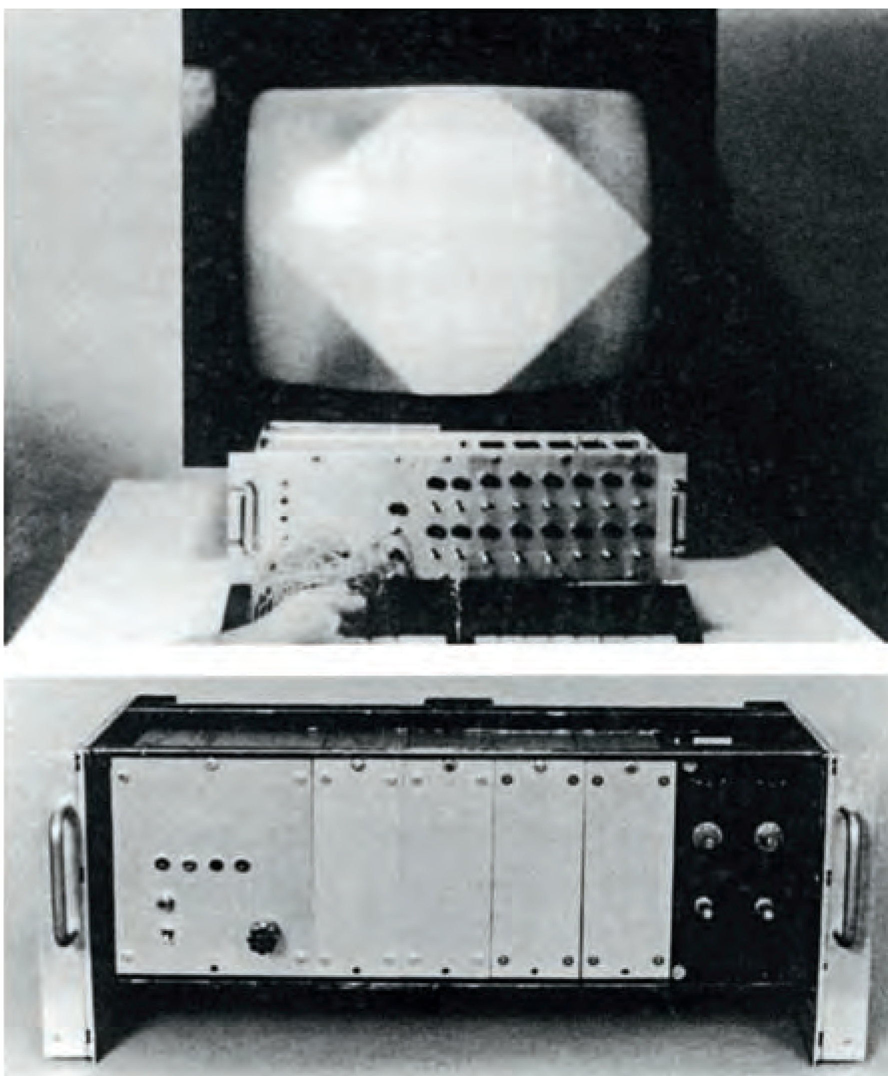
Together these developments in video synthesis, the democratic visions for the new medium, and the new status of color television help explain how *some* of the mystical and utopic values ascribed to video synthesis circa 1969. However, these explanations alone will not suffice. In the remainder of the chapter I introduce three other rationales: one, the newness of the video synthesis color palette; two, historical precedents that link utopia to new color technologies; and three, a *material* transcendence that, I argue, did occur *through* the technology that exists in and as a part of a unique cultural-historical moment.

Eric Siegel’s Generative Color

Born in 1944, Eric Siegel attended high school in Brooklyn and by the age thirteen he had already built his first TV set “from scratch.” In 1960 he won second prize in a science fair for a “home-made closed circuit TV,” a vacuum tube device built from secondhand tubes and miscellaneous parts. The following year he won yet another award: an honorable mention for his “Color

through Black and White TV." While Siegel was dyslexic, when it came to electronics, Woody Vasulka notes, he was clearly a "whiz kid" and indeed, his contributions to the history of color in video synthesis are no less impressive.

From the late 1960s on, Siegel built innovative electronic color synthesizers, which he used to produce psychedelic video artworks, two of which I discuss here.[45] His Process Chrominance Synthesizer (PCS, 1968) was the first device capable of taking a black-and-white video signal from ½ tape or elsewhere, such as a portapak, and turning it into a color signal through the video synthesis process (figure 2.2).[46] Siegel used the PCS to create *Psychedelevision in Color*, a single-channel program consisting of *Symphony of the Planets*, *Tomorrow Never Knows*, and *Einstine*, first shown at Howard Wise's



2.2

infamous May 1969 exhibition, *TV as a Creative Medium*. In the third piece, *Einstine*, the face of Albert Einstein is lit by rich orange, purple, and magenta flames (figure 2.3). For several minutes the face shimmers and morphs into different hues, orchestrated to a soundtrack of Rimsky-Korsakov played on an “old sevent[ies] record” at half speed.

Einstine was originally made in 1968 in black-and-white but was remade in color after Siegel’s friend Tom Tadlock encouraged him to show the piece to Howard Wise, who gave him $300 with which he bought a color television and transformed it into a “rainbow of colors” for the *TV as a Creative Medium* exhibition.[47] After viewing Siegel’s colored *Einstine*, Woody Vasulka wrote, “I always wonder why it took Eric to introduce this new image so convincingly. Something extraordinary happened when we saw that flaming face of *Einstine* at the end of the corridor. For us, something ominous, for me, something finally free of film.”[48] Unfortunately, the archival record of this event, *TV as a Creative Medium*, is a twelve-minute black-and-white tape produced by the Raindance Foundation in 1969 that fails to capture the beauty of Siegel’s elegant, crisp, and carefully controlled color orchestrations. Nonetheless, even after watching *Einstine* and *Tomorrow Never Knows* as single works in 2014, something extraordinary still occurs: the colors, despite decades of degradation, are still rich and otherworldly, a testament to Siegel’s truly unique color system and the “psychedelic” inner visions that inspired it.[49] A closer look at the PCS helps to further explicate how Siegel generated such awesome colors.

2.3

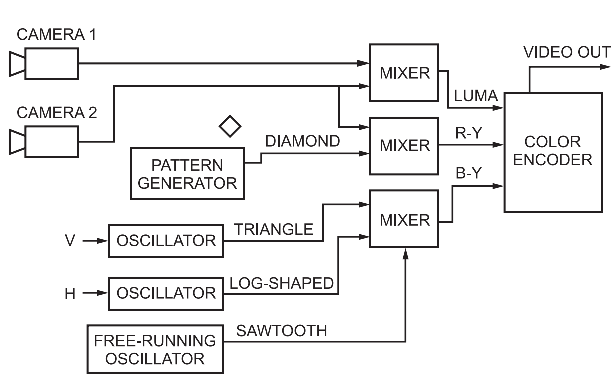
The PCS is a colorizer, meaning that it can add color to a monochrome signal. In the U.S. patent for the PCS, Siegel explains the device’s unique ability

< **2.2** Eric Siegel, Process Chrominance Synthesizer, 1968. This dual colorizer was engineered by Siegel and used in *Psychedelevision in Color*, first shown at Howard Wise’s 1969 exhibition, *TV as a Creative Medium*. Courtesy of Eric Siegel.

2.3 Eric Siegel, *Einstine* from *Psychedelevision*, 1968. Video stills. Produced using Siegel’s homemade Process Chrominance Synthesizer. Courtesy of Eric Siegel.

to provide a means for "producing a color burst signal." A color burst signal is specific to analog video and television, a code used to monitor the synchronization of the color signal or chrominance subcarriers at the beginning ("back porch") of each video signal.[50] In other words, Siegel introduced color information into a black-and-white signal by cleaning the incoming signal of any aberrations and then reinserting a color sync signal, adjusting its brightness, contrast (also known as "gain"), luminance component (lightness), hue (color, also known as "phase"), and saturation (also referred to as "amplitude"). The PCS could then generate chromatic signals for the new subcarrier because it had a new pseudocolor (pseudo implies "false" or machine-generated) component added to the input source.[51] The result was an entirely new electronic color palette, in wild and beautiful excess of FCC and NTSC broadcast standards.

The beauty of this color is illustrated again with his second video synthesizer, the Electronic Video Synthesizer (EVS, 1970). The EVS was the world's first open-system analog electronic color synthesizer, "an instrument for the creation of color visual information," Siegel explains, "with the possibilities of at least one thousand different pattern variations."[52] The EVS could generate images independent of an input source (from film or other forms of optical media), though live camera input was also possible (figure 2.4). Abstract forms were produced using the system's own self-generated colors and free form patch matrix pulled from an IBM card sorter with connections formed by mini–banana plug cables of "adorable colors." The first circuit board was built inside a color television set. The processing amplifier ("proc amp") generated a raw signal, provided it with a black level, blanking signal, burst signal, and sync pulse. (In analog video, the vertical blanking signal refers to the rate at which each scan line is rendered in an image; the burst signal is usually a black burst or black wave that is used to coordinate the broadcast signal with the reception signal, known as the "sync pulse.") The EVS was built on a BIC-VERO rack (a patch matrix board) with front knobs and switches that could be used to track changes on a monitor in real time.[53] By manipulating the knobs, a "wide variety of patterns, colors and motions could be created."[54]



2.4

These technical details, while they are likely obscure to a number of readers, nonetheless help to illustrate the technical challenges Siegel was dealing with; what had to be mastered in order to get *any* color, let alone colors of an "almost unbelievable intensity and richness." And his colors, as noted, continue to appear magical, even on degraded videotapes seen over forty years later. Siegel developed a color system that could, unlike others at the time, activate the phosphors on the TV tube *directly, without the intervention of a video camera*. That is, they utilized the full potential of the CRT tube, which the camera did not do because most analog video signals were at the time AC coupled, meaning AC and DC circuits were connected (the latter blocked by the former) to produce signals that were "highly inaccurate and resulted in an incorrect brightness level on the TV screen." In contrast, with the EVS all signals were DC coupled, ensuring a "complete range from dense black to intense white."[55]

Both synthesizers—the PCS and the EVS—point to the distinction between images produced by optical media like film or photography on the one hand, and those produced post-optically, through synthetic and electronic means, such as computer-generated imagery, on the other. The former bears a causal link between event and image artifact: a photograph is a literal sample of perceivable light from the world whereas with electronic visual media, this link is broken. As I note above, and as I will further elaborate in chapter 6, this distinction is ultimately what places *electronic color in the legacy of technical computing*, not in the history of optical media, at least not exclusively. Woody Vasulka summarizes this difference in regards to synthetic versus representational or what he calls "Bazenian" images: images "taken from God / Nature through the camera versus those constructed inside the instrument."[56] Where Siegel's first synthesizer introduced and modulated color in an image taken from God / Nature (using a camera lens to capture what could already be seen in the world), his second synthesizer went a step further to generate color through abstract, nonoptically based electronic signals. The second synthesizer thus opens aesthetic experience to a new post-optic world through which cosmic and mystical colors seemed quite natural, if not immanent. To put it differently, any image that appeared from the EVS did so only through a synthetic *generative* process, and thus the images were not only "free of film," as Vasulka puts it, but also free of optical media and therefore "natural" vision altogether. Herein lies the second rationale to understand how electronic color in video synthesis became magical and otherworldly: it literally was.

Stephen Beck: Transcendence through Digital Synthesis

In the 1960s, pioneering video artist and engineer Stephen Beck was trained in electrical engineering at the University of California at Berkeley and in electronics and electronic music at the University of Illinois Urbana-

2.4 Eric Siegel, architecture for one part of the Electronic Video Synthesizer (EVS), 1970. Courtesy of Eric Siegel.

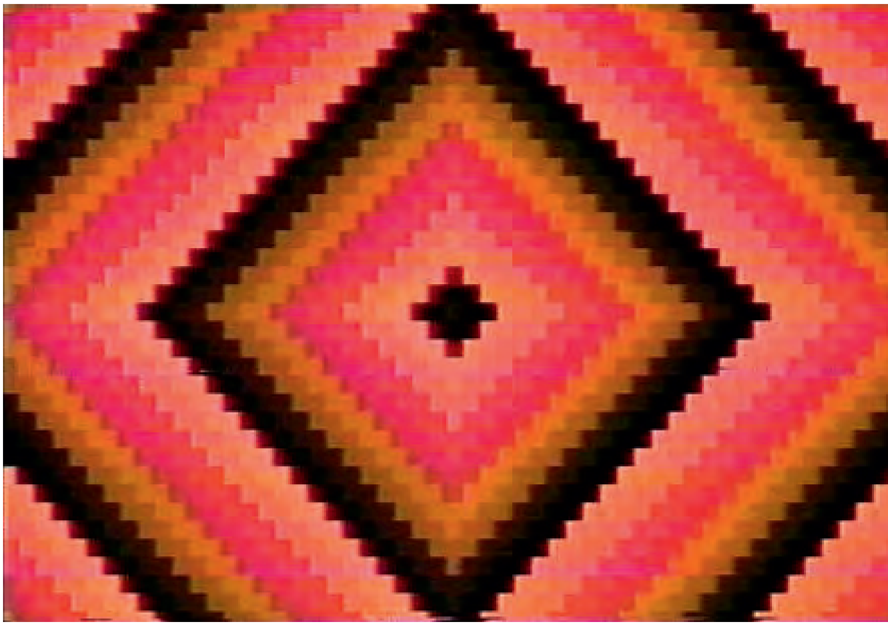
Champaign. As a student he learned electronics, circuit theory, and digital logic, and attempted to engineer a Zenith color television set to generate "color sound" by translating music into a picture.[57] The first synthesizer he built was the Direct Video Zero, an analog direct video synthesizer completed in 1969.[58] The DVZ consisted of a modified color television set with input sources from oscillators and audio signals pulled form a Buchla Electronic Music synthesizer (an early audio synthesizer composed of modules or functional units) used to drive a CRT monitor's red, green and blue electron guns.[59]

Beck's second synthesizer, the Beck Direct Video Synthesizer (BDVS), also used a Buchla synthesizer and was built between 1970 and 1972 under an NEA artist-in-residence grant at the National Center for Experiments in Television (NCET) in San Francisco. Later used for video synthesis experiments at KQED with electronic musician Richard Felciano, the BDVS was originally designed as a performance instrument intended to produce video images without a camera.[60] Beck viewed the system as an "electronic sculpting device" designed to generate four key aspects of the video image—color, form, motion, and texture—which he then used as building blocks in his compositions.[61] The system's image converter was based on a "wipe generator," a device used to generate both horizontal (x-axis) and vertical (y-axis) waveforms from a composite video signal. The system also had positive and negative colorizers that could produce 64-bit color equivalents, with many "illegal" colors and "out of range video voltages" that could be applied to the horizontal or vertical patterns.[62]

After four years in residence at NCET, in 1973 Beck began work on his Video Weaver, another digital pattern generator that used a more precise string of counters and random access memory (RAM) to hold and retrieve stored patterns without locking into a static scanning order. This kind of system is also known as a "fame buffer," which I will discuss in detail in chapter 4. The first Weaver was completed in 1974 and a second more complex version in 1976. The imaging process can be compared to an (electronic) loom, with a vertical warp and a horizontal weft. As video scholar Jeffrey Siedler puts it:

> The pattern is programmed into the memory then "woven" onto the screen by a set of phase shifting counters that slide and shift their count sequence in time to the video raster. A cursor is available to write in the pattern, while various phasing and counter direction parameters are used to offset the scanning order of the resulting video pattern.[63]

Like Siegel's EVS, Beck's system could generate its own colors and image-patterns that exceeded the NTSC standards for broadcast color. Moreover, Beck explains, the colors that appear today in the *Video Weaving* artifacts represent only a fraction of the gamut once visible to audiences during performances and live broadcasts.[64] Unlike Siegel's devices, however, Beck's system



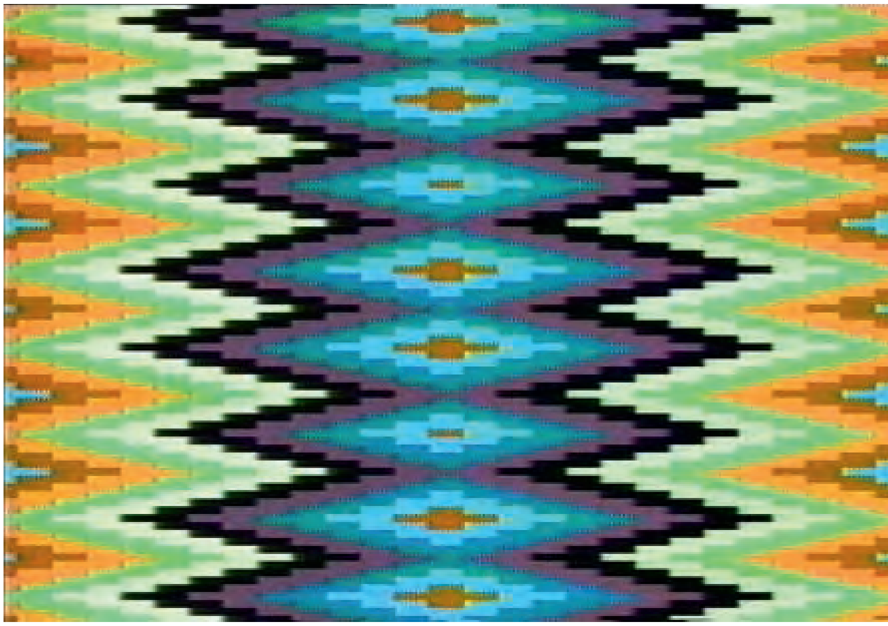
2.5

was a hybrid system that generated its images by transforming analog signals into digital ones and then processing their algorithms in real time.

The *Video Weavings* were first screened at the San Francisco Museum of Modern Art in 1974, where the audience response was "enthusiastic because no one had ever seen digital video synthesized before."[65] Beck also composed some *Video Weavings* for Don Hallock's Videola display unit at NCET in 1973. With support from the Rockefeller Foundation, he attended the INPUT 78 World Public Television conference in Milan and put on an event that inspired an Italian textile company to commission ten *Video Weavings* for use in their fabrics.[66] In 1976, the images were presented for thirty days on multiple CRT video screens in the window displays of New York City's Bergdorf Goodman as part of its spring textiles presentation.

Stylistically, the way in which the *Video Weavings*' rigid and tessellated color patterns move in ongoing horizontal, vertical, and diagonal "ripples" akin to the "warp and weft" of a weave also indicate how and why its aesthetic stands in contrast to the other analog works discussed in this chapter, which are characterized by more fluid, continuous, and smooth colors (figures 2.5 and 2.6).[67] The *Video Weavings* are stylistically (and technologically) more similar to Woody and Steina Vasulka's *Digital Images* (1978), made with Jeff Schier's Digital Image Articulator (a former student of Woody Vasulka), and *Artifacts*, made in the 1980s. Like the *Video Weavings*, these digitally synthesized works also bear a rigid, austere, and geometric look generally absent in analog electronic art and in digital art made after the late 1980s (save for retro-grunge styles like dirt style and glitch aesthetics).

2.5–2.6 Stephen Beck, "Red Diamond" and "Turquoise Chevrons" stills from Video Weavings, 1974. Video, color, sound. The weavings were produced using Beck's digital synthesizer to play on the motif of traditional "weaving" practices, through a markedly digital aesthetic. Courtesy of Stephen Beck, Berkeley, California [www.stevebeck.tv].



2.6

This minor distinction aside, together Beck, Siegel, and Paik all viewed and created work that served as gateway into a mystical realm and reality beyond the cold machine technologies they used to produce them. Beck's images, he explains, were "[b]orn of the inner necessity to project outwardly and share the images seen within my mind's eye—phosphenes, dreams, archetypes, hypnapompic, psychedelic, hypnagogic, and meditation images . . . images I have seen all my life on an inner screen where no camera has yet been invented to record them."[68] Similarly, Eric Siegel emphasized that his *Psychedelevision* was an "attempt at video mind expansion," devised to "reach the inner core of human beings."[69] Television would "bring psychology into the cybernetic twenty-first century," he argued, as a "psychic healing medium creating mass cosmic consciousness, awakening higher levels of the mind, bringing awareness of the soul."[70] In these short passages alone one finds all of the trappings of romanticism and utopianism, here ascribed to the emergence of color in electronic media. This is less surprising, however, when one also considers that such utopic attitudes surround *any* new color technology.

Color and Techno-utopia

Links between color, new technologies, and utopia were already common in the nineteenth century, in the historical moment when color, as Jonathan Crary puts it, was divorced from the world and made "inert and objective." As I note in chapter 1, this occurred primarily through the work of science and in particular, with the nineteenth-century psychophysicists including Gustav

Theodor Fechner, Ernst Heinrich Weber, Hermann von Helmholtz, Johannes Müller, and James Clerk Maxwell and their efforts to quantify, reify, and abstract physiological perception. Coupled with the advent of industrial, chemical, and mechanical processing, color was permanently unhinged from "natural" beauty and lived experience, becoming instead something "standardized, fully quantifiable and controllable."[71]

In response to this rationalization and reification of color, now completely eclipsed from the sacred lifeworld, various romantic artists and writers sought means to return color to its supposed prelinguistic and pre-Socratic origins. In 1857 art critic John Ruskin coined the term the "innocent eye," denoting the ways in which artists could experience and paint the external world with the innocence and purity of a child's vision. Through the innocent eye the world became "an arrangement of patches of different colors variously shaded," which is to say free of signification and thus of social and political realities as well (such as the coal pollution rampant in the industrial era).[72] The irony of course is that *plein air* painting, as an escape *from* modernity, could occur only once artists were equipped with the new mass-produced oil paints and their machine made collapsible-tube housing.

Similarly, circa 1969 the new psychedelic colors of electronic media seemed to offer just such a utopic reprieve and radical alternative to social and political ills (the war in Vietnam, political disillusionment, the violence of civil rights struggles, world-wide explosions and bombings, national and international political scandals, the height of cold war, rising drug addiction, death, suicide, and of course the newly regulated broadcast standards). Color abstraction in video synthesis seemed to provide the perfect escape into a world of pure and innocent (*techné* as) poetic transcendence. In 1970, Gene Youngblood wrote that Siegel's *Psychedelevision* displayed its "colors . . . glowing with an unearthly light, trembling in fierce brilliance, like the colors on the inside of the retina."[73] Both inner eye and cosmic vision became one. The comment is similar to Ron Hays' 1970 claim that with "television . . . you're on the way to being a starchild . . . inner and outer space become one in unknown velocities of a cosmic zoom . . . the now indigo blue of life merge with the glowing beauty of man at his most human."[74] These "innocent eye" sentiments, while they no doubt seem bizarre, were in fact not uncommon in this historical moment of the new color technology's emergence, just prior to its full and inevitable standardization, commercialization, and industrial control. That new color technologies are consistently invested with such utopic sentiments and innocent eye visions, ones that transcend even their own technical-material base, thus provides a third rationale for these colors' imbrication with transcendence circa 1969.

And yet there is still a need for another explanation. There is something about *this* technology—video synthesis circa 1969—that further catapults mystical visions to an intensified pitch. To explore this, I turn to Martin

Heidegger's well-known tool analysis to argue that transcendence and mysticism circa 1969 were in fact normative and concrete.

Material Transcendence

In his 1927 magnum opus, *Being and Time*, Heidegger offers an elaborate theory of being-in-the-world. In one part of the text, Heidegger distinguishes between two basic modes of relating to equipment: the "present-at-hand" (*vorhanden*) and the "ready-to-hand" (*zuhanden*).[75] The first mode is characterized by a distanced, abstract attitude characteristic of scientific empiricism and a theoretical separation between the observer and the object of one's study. In this mode, whatever is being examined is *forced* into visibility through a nonnatural revealing process. When present-at-hand properties are forced to "appear," they are classified into categories and types that then become representative of that object and our epistemological relation to it.

In contrast, the ready-to-hand undermines this approach through its contextualized or "worlded" mode of engaging equipment and things.[76] In the ready-to-hand, the world is intuitive and present, but concealed and inaccessible to representation (representation is a violence of the tradition). In the ready-to-hand, *Dasein* (translated as "there-being") is absorbed into the "equipmental contexuality" of the lifeworld (*Lebenswelt*), as Graham Harman puts it, where things and actions are so close that they recede from visibility and awareness to "conceal" and "withdraw" into themselves. The ready-to-hand is offered as an alternative to the present-at-hand, but both are unavoidable in our relationship with technology.[77]

Often left out of discussions of Heidegger's tool analysis is the more nuanced third term that he calls the "unreadiness-to-hand." In his well-cited hammer example, the ready-to-hand exists when one is hammering away, but when one stops to adjust, the situation shifts, *not*—as one may expect—to the present-at-hand, but instead to the "unreadiness-to-hand." He explains:

> When we concern ourselves with something, the entities which are most closely ready-to-hand may be met as something unusable, not properly adapted for the use we have decided upon . . . *equipment* is here, ready-to-hand. We discover its usability, however, not by looking at it and establishing its properties [the present-at-hand], but rather by the circumspection of the dealing in which we use it . . . This conspicuousness presents the ready-to-hand equipment as in a certain unreadiness-to-hand.[78]

The conspicuousness of circumspection of the unreadiness-to-hand may be seen as a third mode, in between the first two and concerned with *how* one uses things and equipment. It is a partially distanced way of using technology, one that allows things to appear as things, but in such a way that is not fully transparent or withdrawn.[79] The unreadiness-to-hand is thus a *liminal zone* or

shift space where we may add something like *learning with tools*; a pedagogical relation to equipment that is, I argue, both engaged and abstract and therein constitutive of a certain kind of immanence and transcendence.[80]

In the experiments with video synthesis circa 1969, after spending months, even years engineering a synthesizer, one's knowledge of its ins and outs—the subtlety of every button, patch, cable, and circuit board solder, not to mention learning the technical language and processes involved—would have become intuitive. In the time preceding this, one must constantly step back and adjust how one uses one's tools, not for the sake of classifying the particularities into a general theory but rather to see anew, to solve a problem and learn how to approach it again, in such a way that *enhances* habitual and intuitive relationships.

Turning the strange into the familiar and habitual, according to Harman's interpretation of Heidegger, *is* transcendence. Contrary to conventional uses of the term in philosophy—to imply either an escape from the world or, as in Husserlian phenomenology, a transcendental bracketing of subjective "intentionality"—here transcendence denotes the way in which Dasein *ex-ists* in the openness of actual, factical, historical worldhood. Harman argues that Dasein is nothing but transcendence and thus transcendence is simply "another word for *freedom*."[81] If transcendence is akin to freedom and freedom is, I argue below, par for the course in these experiments circa 1969, then Heideggerian transcendence is indeed a valid and *factical* component of this technology and its particular uses, circa 1969. Transcendence *is* the transition from the theoretical hyperawareness of the present-at-hand to the invisibility of the immersive ready-to-hand. Through transcendence technological change is caught. "Hammers, melons, or crystals," Harman writes, "become visible to us only in the ambivalent state of transcendence."[82] In short, transcendence is being in the world and it is ongoing and standard in our everyday relationship with new media.

Transcendence could also be said to mark the way in which new media transition into old media. Once new media become functional and controllable, they become what has been referred to as "dead media," and recede into the background to become "transparent," or ready-to-hand.[83] In this state the technology is functional but one fails to see it. (This is why I will argue in part 3 that such "transparency" is actually an opacity and inscrutability.) Transcendence occurs here as technology becomes opaque: invisible and inaccessible to representation, but transparent and intuitive for use and habituation. This nuanced movement between immersion and reflection helps us understand yet another way in which the complexity of this technology circa 1969 could disappear while one was fully immersed in it!

Being in a world conditioned by science and technology does not foreclose the mystical or other forms of transcendental thought and experience. In fact, ongoing developments and innovations in science and technology are

preconditions for transcendental thought and desires; refueling the inextricable and ancient bond between *techné* and *physis*. In order to extend this argument to the cultural and political milieu at WGBH circa 1969, I now turn to the early video synthesis experiments conducted in WGBH's New Television Workshop.

WGBH and the New Television Workshop

Since 1951, WGBH has been a nonprofit education-based public radio station based in Boston. In 1955 it incorporated the public television channel 2, making itself the first nonprofit television station in New England and a pioneer in public television. In the early years, the studio was full of "Harvard guys who produced boring, black-and-white television." But this all changed in 1958 when visionary producer and director Fred Barzyk arrived and "began experimenting, pushing the studio's envelope."[84]

In 1967 WGBH transitioned to color and new video switchers arrived at the studio. The switches were capable of basic chromakey (the process of removing a color from an image so that another image element may replace it) and titling effects. Artists interested in the new but still expensive media were drawn to WGBH's artist-in-residence program, the New Television Workshop (1972–92). The workshop was supported by grants from the NEH, the Ford Foundation, and Rockefeller, and from it emerged many pieces central to the history of electronic art. Early artists in residence included Nam June Paik, Stan VanDerBeek, Max Almy, Douglas Davis, Peter Campus (discussed in chapter 5), Trisha Brown, Ed Emshwiller, and William Wegman. Fred Barzyk oversaw the New Television Workshop for ten years, during which time he watched, invited, and experimented with "hundreds of artists" who flowed in and out of the studio, all enthusiastic and eager to pioneer a new genre of electronic art.

But even before artists arrived, Barzyk and his WGBH colleague David Atwood were broadcasting experimental programs. In the mid-1960s, Atwood recalls, "we started . . . doing these light shows where we just did whatever came into our head. We mixed black-and-white cameras with telecameras, light show images, and then feedback . . . [we] broke all the rules."[85] The experiments were broadcast in a weekly program called "What's Happening, Mr. Silver?" produced by Barzyk and hosted by Tufts University professor David Silver. One episode, "Madness and Intuition," later mentioned in *Newsweek*, was created in the spirit of avant-garde composer John Cage.

In Cage's theory, Barzyk explains, all sound was music, "therefore any picture is a television show. We applied that theory to a half-hour show." The result:

> I got two ninety-year-old people to sit in the middle of the room. I had Ed Beardsley on a motorcycle traveling around. There was smoke going, people dancing . . . the host was in bed with this girl talking about Velikovsky and destruction of the dinosaurs . . . . About halfway through I said, "If anybody is

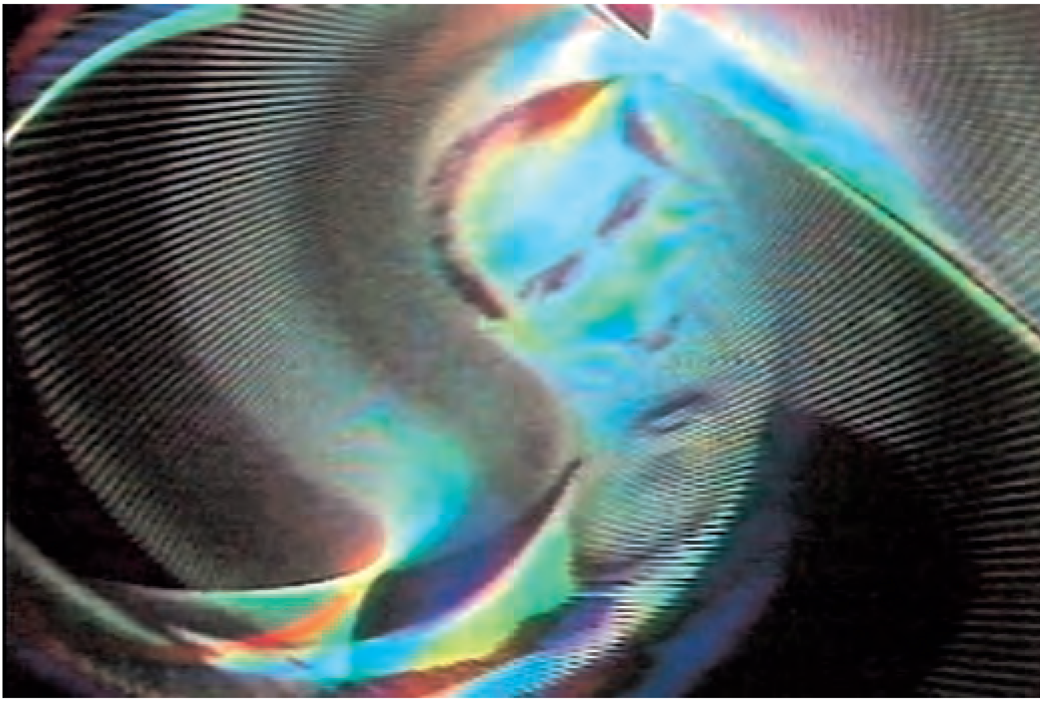
> bored just yell out and I'll change it to something else" . . . it didn't make any difference what followed.[86]

At the time, Barzyk and Atwood saw themselves as directors "fooling around with TV: in hopes of making a change and bringing out the '60s feel to some of our shows on public television."[87] After realizing the vast possibilities for video in this relatively open-mined setting, they got a grant and the doors opened. Most doors opened.

Those behind the doors to management and on the executive level viewed the incoming artists as a disaster waiting to happen and, after Paik's early residencies at WGBH, it is hard to argue with them. At the same time, the wild and unruly experiments that Paik conducted at WGBH (noted below) are today heralded as cornerstones in the history of video and new media art to which Paik brings esteem to the WGBH name.

WGBH's national broadcast of *The Medium Is the Medium* in March 1969 featured the work of six artists: Allan Kaprow, Nam June Paik, Otto Piene, James Seawright, Thomas Tadlock, and Aldo Tambellini, each of whom made a short video using WGBH equipment. By far the most "controversial" contribution came from Paik with his *Electronic Opera #1*. For the segment he brought a dozen "prepared televisions" into the studio, used three color cameras to mix the images with a nude dancer, tape delays, and positive-negative image reversals. Paik's *Opera*, as Youngblood puts it, consisted of "dazzling silver sparks against emerald gaseous clouds; rainbow-hued Lissajous figures [that] revolved placidly over a close-up of two lovers kissing in negative colors; images of Richard Nixon and other personalities in warped perspectives [that] alternated with equally warped hippies" (figure 2.7).[88] The piece was set to the soundtrack of the *Moonlight Sonata*, interrupted periodically by Paik, who looked at viewers, yawned, and announced, "life is boring." He instructed them to "close one eye" or "close one eye half way" and finally, "turn off your television set."[89]

The *Opera* was controversial for its strange technical setup, unorthodox content and the use of Nixon's head twisting through synthetic video effects, but above all because it featured a topless dancer. The dancer was supplied by a "WGBH type," Atwood explains, who had "connections everywhere in Boston. We never knew from where she came and never asked. She showed up, took off all but panties, stood on a pedestal, was directed by Paik, was recorded, and left . . . . It was a minor scandal at the time."[90] A topless dancer was definitely not what the station expected or hoped to see from a show on "the arts." But at this point the show was already receiving national recognition and strong support from the Ford Foundation, so the studio (reluctantly) honored such requests.[91] After *The Medium Is the Medium*, the Rockefeller program was created and Paik returned to Boston as a full-time artist in residence.



2.7 After the studio made the transition to color in 1967, a new financial arrangement required everyone to pay for studio time. This became expensive because with color the set-up time multiplied exponentially: it would take “all day to get it right,” whereas with black-and-white, they would “be ready to go in minutes.”[92] Frustrated with this, in 1970 Paik set out to create a low-cost alternative, a color manipulation system that resulted in the Paik-Abe Video Synthesizer (PAVS) (figure 2.8).

2.8

The Paik-Abe Video Synthesizer

Initially dubbed the Wobbulator, the PAVS was a homegrown keyer, colorizer, and scan modular system engineered with limited financial resources by Paik and his childhood friend, the engineer Shuya Abe.[93] In the haphazard and scavenger style that came to define him, Paik built the system using second-hand wires, television sets, and hardware parts (a method that stands in stark contrast with Siegel's systematic control and organization of every color and function). Barzyk recalls finding Paik setting up in the studio one day wearing tall rubber boots. Upon inquiry, Paik explained: if I don't wear them, "I get electrocuted."[94]

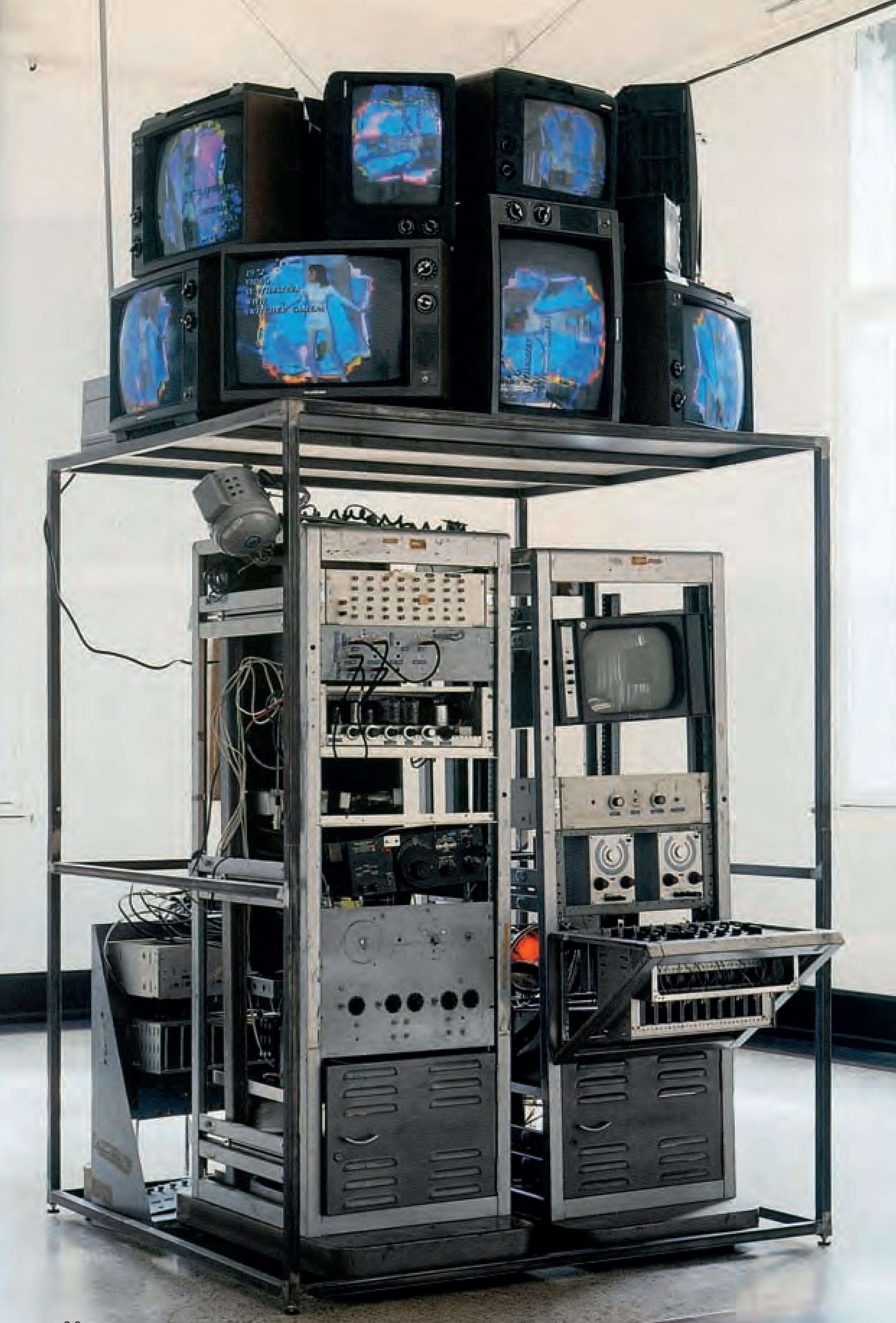
Before the PAVS made it to the studio, it lived in the front room of the apartment Paik was sharing with David Atwood. During the summer of 1970, they made the move to WGBH, where they transformed an old studio into what looked like an "electronics junk shop combined with a cheap trinket store." In its new home, the PAVS consisted of multiple television monitors, surveillance cameras, and two color encoders—the first encoder was built into the second to allow for a broader range of image manipulation and colorization possibilities. The system could take between ten and twelve black-and-white inputs, an impressive number considering that at the time the studio's own mixers were limited to three. (figure 2.9).

For special effects Paik also sought low-cost, highly creative alternatives. He "bought all manner of crap," Atwood explains, "plastic dishes, cheap busts of famous composers, and anything plastic that cost nothing and would distort light." He even used a record turntable to construct and spin objects at either 33 or 78 rpm, upon which Barzyk once found "a mound of shaving cream . . . whirling around on top." Another roommate of Paik's recalls that he even made his bed out of old console TVs with a mattress placed on top. He ate off of disposable paper plates and used plastic utensils, which, he argued, were the "greatest American invention." Paik's style was fast, cheap, and messy but effective: under the studio lighting, the rotating shaving cream "transformed into a mélange of color and images."[95] Paik's *9/23/69* for instance (made on September 23, 1969, in collaboration with Atwood, Barzyk, and Olivia Tappan), offerred a showcase of the wide range of effects, mixed media, collage-techniques, and colorization methods possible with the PAVS (figure 2.10). While *9/23/69* was never broadcast in its entirety, parts of it were later integrated into the PAVS's broadcast premiere.

On August 1, 1970 the PAVS embarked on its maiden voyage on public television's channel 44 in a four-hour debut called *Video Commune: The Beatles From Beginning to End*, a broadcast of "far out imagery never before seen by the world." *Commune* featured a variety of images, such as Japanese television commercials remixed through the synthesizer and set to a Beatles soundtrack, providing at least one element of continuity in an otherwise unstructured visual spectacle[96] (figure 2.11).

2.7 Nam June Paik, *Electronic Opera #1*, broadcast on WGBH's public television channel as a part of *The Medium Is the Medium*, 1968. Courtesy of Nam June Paik Estate.

2.8 L to R: Fred Barzyk, Shuya Abe, and Nam June Paik with the Paik-Abe Video Synthesizer at WGBH-TV, Boston, circa 1969. Photograph by Conrad White. Courtesy of Nam June Paik Estate.



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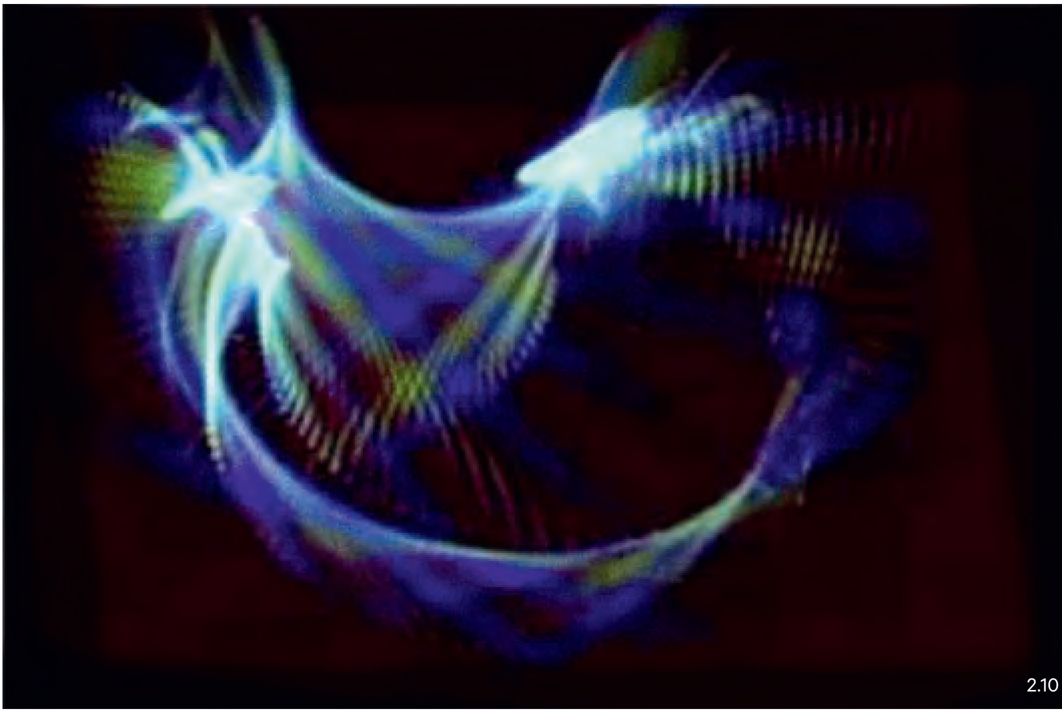


< **2.9** The Paik-Abe Video Synthesizer (PAVS) in 1992 [1969]. 12 monitors, 2 video disc players, 183 × 56 × 66 cm. Courtesy of Nam June Paik Estate.

2.10 Nam June Paik, *9/23*, 1969. Video still. This image was created using the Paik-Abe Video Synthesizer. Courtesy of Nam June Paik Estate.

2.11 Nam June Paik, *Video Commune: The Beatles From Beginning to End*, 1970. Video still. A broadcast of "far out imagery never before seen by the world," using the PAVS at WGBH-TV. Courtesy of Nam June Paik Estate.

While *Video Commune* marked a “milestone” in the transformation of broadcast television, using the PAVS, let alone controlling it, was another issue altogether. Even Paik admits the PAVS was a technical nightmare. It’s a “sloppy machine,” he said, “like me.” Atwood concurs, it was “a miracle that it even made an image.”[97] The WGBH engineers, who sat at the mixers and switchboards in the control room, hated the PAVS even more, just as they hated the ways in which the artists “incorrectly” used the expensive studio equipment (“holding down three and four buttons at once,” a [Cagean] method that had the engineers “in agony”).[98] There was also a time when, during the PAVS’s debut on channel 44, it burned up the studio’s very expensive chromo filter transmitter. Paik simply ignored FCC color limits, which is also to say he neglected to run his colors through the vectorscope and compress them.[99]

These “artistic” techniques led to constant “back and forth” negotiations between the artists and the engineers regarding which colors would be allowed in that day. “Every time we record[ed],” Atwood explains, “we had to go through this little dance with the engineer . . . assigned to: ‘synthesizer recording.’”[100] The debates were exhausting and repetitive, and Atwood eventually found a way to get around them. He realized the overall chroma phase could be adjusted by adding or subtracting video cable at the point where the signal plugged into the wall. The formula was two degrees per foot of cable. He explains:

> The synthesizer had moved to a little small room right across the hall from master control . . . and the engineer would say, “Well I don’t know where the patches are.” . . . I would say, “Well, I think they’re there” (I’m not supposed to know this) and then they’d look at it and say, “No, that’s too extreme, we can’t do that.” I’d say, “What’s wrong?” They’d say, “It’s out of phase . . . like 40 or 50 degrees, we can’t correct for that.” . . . I had this whole pile of video cable [which he hid “behind the racks in a plastic green frog kid’s tub”] and I’d do the math in my head . . . plug in [the extra cable] and I’d go back and say, “Well, how is it now?” “Oh, it’s close now.” This was a dance that we went through almost every time.[101]

Paik appears to have eventually found value in keeping his colors within the FCC range. In a letter written to WGBH executive Michael Rice in 1971, he reports having used the “Tektronix Vectorscope” with John Godfrey at WNET to monitor the “chronical chroma overlevel . . . to create brilliant and complex color images” that, he boasts, were “within the FCC limit.”[102] He appeals to Rice for funds to purchase the Heathkit Vectorscope (costing $145 in 1971) so that similar FCC-approved colors could be made at WGBH. While this device may have helped control the overall color for broadcast, controlling *specific* colors within the PAVS was yet another issue.

After Paik left WGBH video artist Ron Hays arrived in the mid 1970s and devoted numerous hours to cataloging and indexing the PAVS’s image and

color parameters (figure 2.12). His journal from the time explains, "Describing the color control of The Paik Abe Video Synthesizer is difficult . . . Since color is nominal to each channel, final color potential can only be discovered by trial and error during the image-growing processes." Not only were colors inconsistent, different colors were responsible for generating different visual effects and feedback patterns. "For instance, a color base of green will produce a more explosive feedback image than a color base red. At the same time, the base will be varied every time a new channel input is faded up from another image." With the PAVS, Hays concludes, "color constants do not exist."[103] 2.12

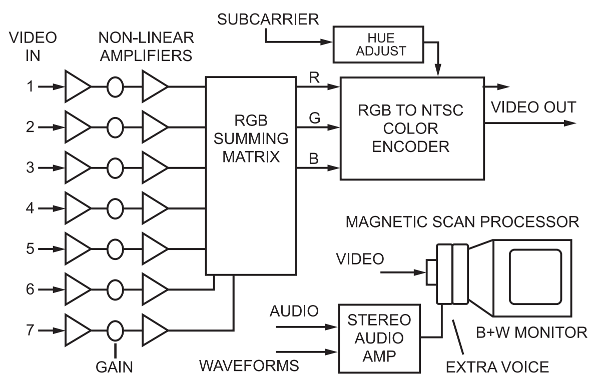
He eventually classified five general output parameters. These image "archetypes," as they were appropriately called, were:

1. Sweep Modulation Pattern A
2. Sweep Modulation Pattern B
3. Paik Dancing Pattern or Wave-form [most likely a lissajous]
4. Sine-Square Oscillation
5. Feedback images [which occurred when the synthesizer cameras were not being used to pick up the above listed image-archetypes, but were instead pointed at the display monitors].[104]

One of the main difficulties of creating a systematic color language for the PAVS arose from the fact that it had two color encoders connected to each

2.12 L to R: Ron Hays and David Atwood using the PAVS. The photograph is "staged but accurate," according to Atwood, taken in the early 1970s when the PAVS was docked in the Green Room at WGBH, across the hall from master control. Photographer unknown.

other (figure 2.13). “Encoder one’s image quality is much more ‘soft’ than the more ‘metallic’ or brighter images on Encoder two,” Hays explains, a disparity amplified by the fact that each camera (which also functioned as a synthesizer) had its own personality, so depending on which encoder it was connected to, it would alter the image in unknown and unpredictable ways.[105] In sum, the color was completely unstable, ephemeral, and unstandardized. This kind of system must be seen in dramatic contrast to the more recent and so-called objective color systems available with “off-the-shelf” commercial software applications where color choices are predetermined, preselected, and therefore, generally speaking, also always predictable.



2.13

Near the end of his notes Hays instructs future users to learn the PAVS system intuitively, “You must learn how and where to reach for the gain knob and how fast and how far to turn it by watching what it does. Turning a gain knob too fast can destroy the innate beauty of an image.”[106] To “know” the range and sensitivity of each knob, while no small feat, was to move from the unreadiness-to-hand (even in its most present-at-hand form) to the ready-to-hand, where immersion in the technology and its “personality” becomes so effective and intuitive that the *fact* of technology recedes.

Technics and Equipment as Environment

In a sense Heidegger’s notion of the ready-to-hand is similar to Benjamin’s 1936 observations about new technology. Benjamin writes, “For the tasks which face the human apparatus of perception at historical turning points cannot be performed solely by optical means—that is, by way of contemplation. They are mastered gradually—taking their cue from tactile reception—through habit.”[107] Technology is naturalized and legitimated in the lifeworld through embodied practices and uses. While both Heidegger and Benjamin were critical of modern technology, Benjamin, very much unlike Heidegger, argued that certain political and socially astute uses of technology could harness revolutionary potential.[108]

And yet Benjamin's analysis, while insightful, is void of the systematic ontology that Heidegger's philosophy offers, an approach that, precisely because of its breadth, also allows us to see how technology is inclusive of cultural history and epistemology. I discuss this in detail in the introduction, so just to reiterate here, Heidegger writes:

> From the earliest times until Plato, the word *techné* is linked with the word *episteme*. Both words are terms for knowing in the widest sense. They mean to be entirely at home in something, to understand and be expert in it. Such knowing provides an opening up.[109]

As I argued in the introduction, technology, which is also to say equipment, is not restricted to "objects" for practical use, like hardware or "tools," but instead includes history, infrastructure, memory, knowledge, and cultural convention. It is a mistake to see technology as a mere tool or piece of hardware, both Harman and Kittler warn, an oversight that arises from anthropocentric approaches where the use of a term like "tools" raise questions like tools *for whom*? Both equipment and technology, Harman writes, "have nothing more to do with instrumental devices than with angels or with flowers along the Ganges."[110] And thus "technics" is perhaps a more suitable term, especially after the industrial era when technics are undeniably bound to all forms of life and culture in a "media ecology."

Technics at WGBH circa 1969 must be seen in these terms, as inclusive of the open-minded directors, the at times supportive engineers, the NEH and Rockefeller funding, the workshop itself, their relative freedom to explore and experiment as they wished, the broader social and politically progressive context of the U.S. in the late 1960s, the unstandardized hardware, and the various collaborations between artists, directors, and engineers. Consider for example how this anecdote offers a telling picture of the then open and playful atmosphere:

On June 23, 1970, seven days before *Video Commune* aired, Fred Barzyk received a memo from the then president of WGBH, David O. Ives. In the station's program guide, Ives had seen the listing for August 1, 9:00 pm to 1:00 am. On blue WGBH stationery he wrote:

> Barzyk
>
> I have just seen the program guide piece on the Paik experimental broadcast for Aug 1. I strongly suggest that, if you have not already planned it, you prepare some videograph copy and run it onto the screen every . . . ten or 15 minutes, at least early in the show. Copy should indicate that it is an experiment, that it is better seen in color, that it has no formal start or finish, etc. Just something to keep down the volume of complaints as to what the hell you communist, pinko, Maoist, bastards are doing. Also, be sure to supply the switchboard that night with all the necessary soothing talk for complaining callers—DOI.[111]

2.13 Nam June Paik and Shuya Abe, architecture for one part of the original Paik-Abe Video Synthesizer, 1969. Courtesy of Nam June Paik Estate.

"Of course he wasn't serious about the 'communist pinko Maoist bastards' part," Atwood promptly adds.[112] Striking about this story, however, is the freedom within which these jokes occurred. Any president today, whether corporate or otherwise, would see this memo only in terms of lawsuits and litigation fees. The kind of work that *could* be produced at the studio emerged from these experimental and playful equipmental backgrounds, which in turn helped to shape and produce the technology and its aesthetic sensibility. Again, because technics is integral yet often invisible, and in no way exclusive to "tools," physical objects or machines, the notion of technics-as-environment bolsters the trope of transcendence, as both concrete and practical. The Ives memo, as weird and funny as it is, points directly to this unique cultural and historical moment when play, experimentation, and a significant degree of freedom were constitutive of the equipment and technics, as an environment or media ecology, which collectively molded the new media and invested it with a visionary and utopic ethos. Further, that this new medium would eventually land in the technocratic televisual and cinematic effects industries that it has, could not have been known at the time, and herein lies another reason why the essence of "newness" in a new medium may also be understood in relation to a transcendent techno-utopia.

The End of the Liquid Rainbow

By the late 1970s, these wild and psychedelic color experiments were harnessed for stable commercial and industry applications. This occurred primarily through the Scanimate, a relatively unique analog computer system used to optically *scan* and *animate* text and color overlays for the television and film industries (at the time, other comparable systems included the Animac and Ceasar, developed by the Computer Image Corporation). Like most of the video synthesizers discussed in this chapter, the Scanimate was capable of manipulating a video signal, but it was also connected to a scan converter where high-contrast color artwork could be placed onto a light table and scanned by a "high rez" camera (a progressive scan monochrome camera) that ran at the NTSC or PAL field rate.[113] In the late 1970s, each scan was about 500 lines on a vidicon camera.[114] Once brought into the system, the image was rescanned into a regular monochrome NTSC video signal. After rescanning, the computer could be used to "do all sorts of weird and wonderful things," such as a "sweep on the CRT . . . [to create] horizontal and vertical sawtooth waveforms [or] a variety of oscillations," similar to those produced by Paik, Beck, Hays, and Siegel.[115]

However, the Scanimate was more programmable that the other video synthesizers discussed in this chapter. The original raster image could be "sectioned" or "segmented into as many as five different parts, each capable of independent movement in synchronization with any audio track, either

music or commentary."[116] For output, a second camera would monitor the CRT performing the animations and record it directly onto film or videotape. The output image could also be layered by "keying" it over a videotape of previous "passes" recorded on a two-inch IVC helical analog video recorder attached to an enormous playback system.[117] Pioneering Scanimate operator Dave Sieg explains that at that time the animator had to program the moves by wiring up a complex analog circuit and adjusting any and sometimes all 250 knobs through several patch panels. Because they had to literally wire each animation together, the animator was really more of an engineer than an artist. This led to a phenomenon where only a few skilled workers using these unique machines could generate the animated video and film graphics for an entire industry.[118]

Lee Harrison III and Francis J. Honey planted the seeds for the Scanimate at the Computer Image Corporation in Denver, Colorado, around 1967.[119] By 1969, Harrison built the first official Scanimate as a hybrid two-rack unit system to which he eventually added more modules and racks in order to give it more functions and flexibility. In 1970 Harrison moved the Scanimate to Hollywood, where it became a part of Image West Ltd. and began to receive industry recognition, especially after they had two active systems in use by 1979. The Scanimate reached the height of its popularity between 1978 and 1982, though they were still used in various sectors of the industry through the mid-1980s. Aside from the two Scanimates located at Image West, five other systems were exchanged between Tokyo, London, Australia, Luxembourg, New York, Denver, and Phoenix.[120]

At Image West the video switcher and monitors were housed in a room at the front of the studio and in another room sat the videotape machines: 2,000-pound "monsters that ran on megawatts of power and required compressed air."[121] In 1979 Sieg arrived as a maintenance engineer. Despite hardware burdens, he explains, part of the system's appeal was that it could generate output in "real time" so that clients from Hollywood's film and television industries could sit on couches in the studio and watch and direct what they wanted, for a fee of $2500 an hour. The system was hundreds of times faster than film or cell animation, so paying the steep fee to have quick and total command was a bargain for many. Of course, if a client spent time being indecisive, they "literally paid for their indecisions."[122] The Scanimate's uses and applications were limited to commercial television and film, including a brief scene of the Death Star emerging from behind a planet in the first *Star Wars* film (1977); a live animation broadcast during the Grammies in 1977; the entire series of "spaghetti" letters and oscillator effects for the *Electric Company* and Ron Hays' Earth, Wind & Fire video, "Let's Groove" (1981) (figure 2.14).

In 2009, a Hollywood studio on behalf of the ad agency Goodby Silverstein & Partners approached Sieg, who owns one of the few remaining Scanimates, and requested to use it to shoot a vortex scene in their upcoming *Got*

2.14


2.15

Milk production of a new rock opera about milk, *Battle for Milkquarious!* starring White Gold, the marketing product of the California Milk Processor Board and Goodby Silverstein (figure 2.15). They pleaded with him: even with all the effects and plug-ins available, they still could not get close to the look and feel of the Scanimate. It would have been next to impossible to shoot the entire scene using only the Scanimate, not to mention the time and money requirements, so as a solution they decided to use a sophisticated HD Red Digital camera at 4k resolution (4,000 pixels per square inch) to shoot the Scanimate output images off the surface of a CRT.

After three days of shooting, they were pleased with the results, which, to their minds, gave them the "look of the real thing."[123] Their resultant colors are very saturated, like a liquid rainbow, but to my mind, they are more nostalgic

< **2.14** Earth, Wind & Fire, "Let's Groove," 1981. Video still. Colorful liquid rainbows accompany groovy music. The effects were produced by Ron Hays using the Scanimate.

2.15 *Got Milk* with Goodby Silverstein & Partners, "Vortex Scene" scene in *Battle for Milkquarious!* 2009. Video stills. Colored effects in a rock opera about milk. The goal was to emulate the look of the original Scanimate system.

2.16 because exceedingly static and precise in their simulation. The digital images are flat and fail to capture the fluidity and richness of the dirtier analog colors. One reason for this is that the original Scanimate colors are analog CRT colors. That is, they are materially and technically dirtier because their phosphors are less precise and often blurred on their trace points. In contrast, with LCD screens (which most computers have), liquid crystals are “sandwiched” together between two layers of polarized glass, a more precise arrangement ensuring that, if no voltage is applied, light will not travel through the layer or move onto the next.[124] An attempt to avoid this flat and clean aesthetic may have been made by photographing the images off the surface of a CRT screen, but ultimately they were redisplayed on an LCD for final viewing.

This nostalgic digital flatness is illustrated again with Mac’s Flurry screen saver, which also attempts to simulate the analog liquid rainbow aesthetic (figure 2.16). The rainbow Flurry animation is continuous and ongoing, but it is also stale and bears a highly calculated look, which of course is desired in certain situations, but aesthetically is without dynamic composition (the same could be said for a number of digital effects). Moreover, its precise asymmetrical movements are mirrored by an equally flat color gamut of unilaterally whitish hues. In short, the screen saver is “democratic,” as I term it in chapter 4, where no single hue or segment is privileged over another, making all colors

and movements equal but homogeneous. At the same time, the Flurry screen saver is a slightly unfair comparison because it is assumed that a screen saver would intentionally be subject to intense compression algorithms, unlike the significantly wider color gamuts used in high-end industry films or commercials. Nonetheless, digital animation, which includes a significant chunk of contemporary video art, while colorful, tends to bear this same flattening affect absent in the older, relatively uncompressed CRT animations.

To be clear, this is not an ethical or evaluative claim about the difference between analog and digital images. Computer-generated analog animations from the 1960s through the 1980s, while full of noise, *were* more fluid and richer in color depth, relative to digital imaging, which has since become cleaner and more sophisticated, due to the frame buffer (a rendering device that allows color information to be stored, repeated, or efficiently recalled, as discussed in chapter 4) and the alpha channel (discussed in chapter 5), but also radically compressed, due to LCD screens and practical conventions for media distribution and transmission. By the mid-1980s, the bulky and unstable analog systems were phased out in favor of the new and efficient frame buffers and CGI technologies, such as the AMPEX ADO. Alongside the rise of video cameras and editing systems in the 1980s, the marketing of personal computers, digital effects technologies, and the Internet in the 1990s, it became unnecessary to travel to centers like WGBH or WNET for artist residencies or to Image West for expensive analog color effects. And thus, the New Television Workshop peaked between 1968 and 1972 and officially ceased production in 1993.

Synthetic Mysticism

The world of video synthesis circa 1969 was for many, one of transcendental immersion and cosmic union between humans and machines. Looking at this work today, the heavy mediation and synthetic effects used in the work of Siegel, Beck, Paik, and others not discussed here (like California-based Scott Bartlett) make the work seem that much more distant and alien (the opposite of immersive).[125] In part this occurs because one now views the work through the contemporary filters of abundant commercialization, the speed of MTV culture, and the ubiquity of meaningless “content” on the Internet. In contrast, in 1969, the radicality of these colors symbolized pushing the new media in new and unforeseen directions, into an optimistic future not yet conceivable.

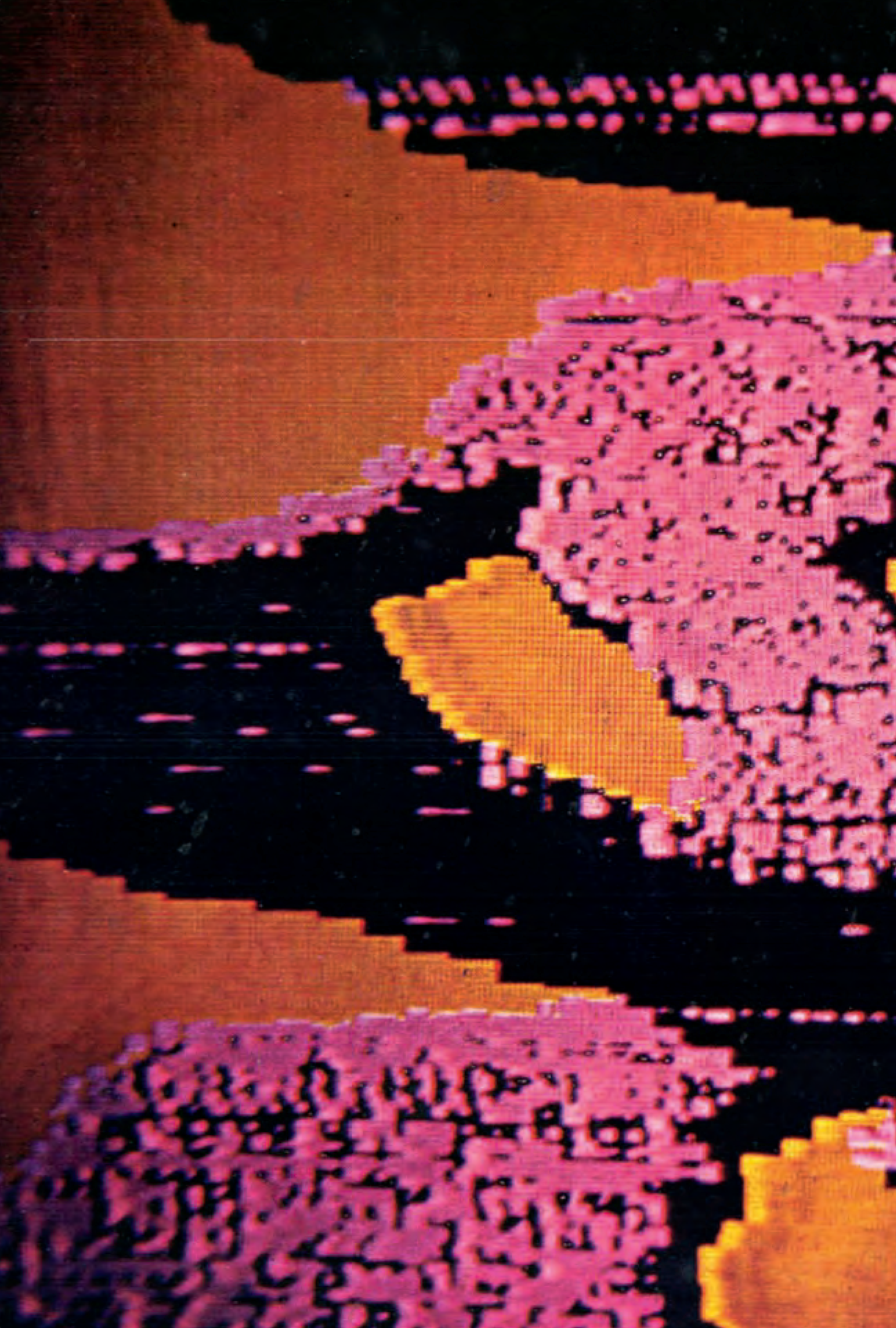
The video synthesis pioneers discussed in this chapter developed techniques to make color visible in a medium where it did not yet exist, a feat that alone imbues video color with a magic and transcendental value. And, as I noted at the beginning of the chapter, the mere act of watching television engenders a cybernetic loop where the signal is integrated with subjective perception, eradicating any clear distinction between subject and object, bringing “us” into

2.16 Mac’s Flurry screen saver, circa 2014. The rainbow hues simulate obsolete analog video synthesizers.

a “spiritual embrace” with the same medium that brought us to the moon and (back) into the cosmos. Moreover, if it is *through* these pure and abstract colors of the electronic signal that the “medium” becomes “the message,” which a number of these works seem to propose, then the message of this medium is one of the pure and transcendental melding of minds and souls: “the art of pure relations,” as Paik puts it. So while the mystical video synthesis produced circa 1969 may have at first seemed misguided, given the radically new and unstandardized technology, the utterly alien color palettes these pioneers generated, the relatively free and unfettered experimental approach to the work, and the liberal and supportive social, political, and cultural contexts that bolstered them, these mystical and utopic visions should now seem grounded by material fact and concrete circumstance.

Circa 1969 the “now-indigo blue” of video synthesis symbolized and instantiated a techno-transcendental immediacy, an “equipment-free aspect of reality” that Benjamin once identified as the “blue flower” in the land of technology.[126] The blue flower not only brings the sacred and mystical to the *surface* of the techno-image but also fulfills the revolutionary function of what technological art is supposed to do. In Benjamin’s account, this was to break the hermeneutic veil that kept art in secrecy, making it instead immanent in-itself—transcendent through color—and yet also accessible for mass experience. Heidegger, however, would have been in strict *disagreement* with this goal. In fact, the easy and widespread consumability of art was precisely one of the “dangers” of technology that he warned against.[127] Regardless, pure and unmediated cathode ray blue appeared circa 1969, but it did so only *after* these pioneers and visionaries, supported in the above-noted situations, transformed highly technological processes from the strangeness of the unreadiness-to-hand of a foreign new media into a naturalized element of the lifeworld. This cool blue revolution—whether Heideggerian or Benjaminian—could *only* be televised.

The way in which synthetic electronic colors transcended both the empirical *and* the optical conditions of media and the moving image circa 1969 sets the stage for the book’s larger arguments for a shift from color’s optical paradigm into what I term the “post-optic” paradigm of algorithmically generated electronic color. However, this shift will not be teased out until chapter 6. Before this, I turn in the next chapter to color’s encounter with number and digital code, that is, to the shift from color in analog computing into the discrete world of the digital.



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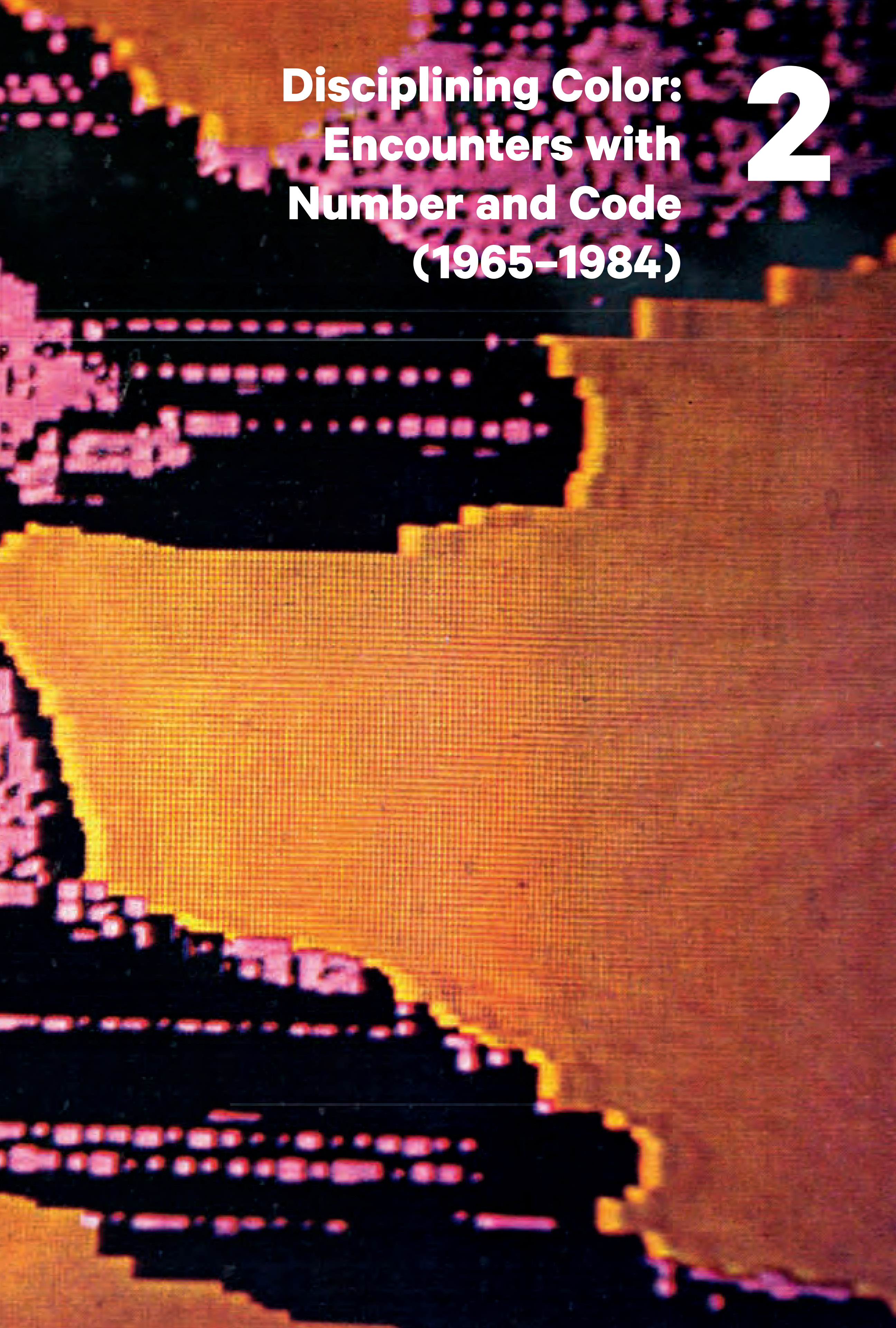
Disciplining Color: Encounters with Number and Code (1965–1984)



Chapter Three

Informatic Color and Aesthetic Transformations in Early Computer Art

> Color shines and only wants to shine. When we analyze it in rational terms by measuring its wavelengths, it is gone.
>
> —Martin Heidegger[1]

> The control unit of the drawing machine interpreted the coded commands so that the step-engines moved the drawing head with its pens according to the speeds currently requested. . . . So the computation only knew there is color no. 1 and color no. 2. It had no idea of what these colors looked like.
>
> —Frieder Nake[2]

In the previous chapter I analyzed color primarily in experimental analog computing. In this chapter I turn to experimental color primarily in digital computing, an analysis that will continue through chapter 5, with some examples of analog computing remaining in play. Specifically, in this chapter I explore how notions of uniqueness and originality, which have surrounded art practices for centuries, are challenged by the advent of computer art. These issues are faced head on in the writings of German mathematician Max Bense and in his project for rational aesthetics. Bense's theoretical work accomplishes the opposite of traditional aesthetic pursuits: a "Programming of the Beautiful" through the scientific and mathematical rationalization of art making, the role of the artist, and color. I use Bense's theoretical groundwork to highlight the mathematical thinking necessary to produce even the most rudimentary colors in early computer art, which I illustrate through the work of German pioneers Frieder Nake and Herbert Franke, and Dutch pioneer Peter Struycken. In the second part of the chapter, I compare these Europeans' work with early U.S. practitioners including John Whitney Sr.,[3] Stan VanDerBeek, Ben Laposky, and Mary Ellen Bute. This comparison makes clear that the rational, European (though mostly German) style is generally distinct from the U.S. style, characterized by expressionistic, mystical, and at times utopic uses of color and postwar technology (a reading consistent with my analysis in chapters 2 and 4). While counterexamples are noted throughout, the chapter's overall comparison between a "German" and a "U.S." approach to color in early computer art, while general to be sure, allows me to map out fundamental strengths and shortcomings in either approach.[4]

Programming the Beautiful

The project to Program the Beautiful first emerged as the fourth volume of German mathematician Max Bense's *Aesthetica* in 1960, a five-volume book project in rational aesthetic theory: the endeavor to quantify art and aesthetics into a mathematical science. The provocative series took its title from Alexander Baumgarten's 1750 *Aesthetica*, a text that, two hundred years earlier, introduced the term "aesthetics" to philosophical discourse and argued that the field merited the status of a science.

Within the humanities, scholars first met Baumgarten's claims with fear and rejection. Immanuel Kant was one of the first to voice resistance to Baumgarten's thesis. In his 1781 *Critique of Pure Reason*, he argued:

> The Germans are the only people who currently make use of the word "aesthetic" . . . Baumgarten, that admirable analytic thinker [brought] the critical treatment of the beautiful under rational principles, and so [sought] to raise its rules to the rank of a science. But such endeavors are fruitless.[5]

One may wonder how Kant might have reacted two centuries later, when Max Bense also proposed a science of art, though one without even the benefit of empirical observation.

Some of Heidegger's early critiques of technology suggest Kant's likely position. Heidegger worked in the tradition of the humanities that, since Husserl, critiqued and renounced mathematics and science from qualitative inquiry. "In algebraic calculation," Husserl writes, "signification recedes into the background as a matter of course . . . one calculates, remembering only at the end that numbers signify magnitudes."[6] As abstractions, mathematics and numbers were sworn enemies of the contextually rich and nuanced lifeworld. But the lifeworld had its limits: even Hegel's systematic theory of colors, notes German media theorist Friedrich Kittler, "could do no more than repeat and deepen what natural languages said about colours in the first place."[7] Following the work of his forefathers, Heidegger kept his colors safe in the qualitative lifeworld and clung to Romantic notions of pure color "shining forth" from within its mysterious core.

Today Bense's project must be contextualized within and against this rich philosophical tradition, by virtue of his attempt to marry computation and creative thought. When his 1965 project for programmable art brought together mathematics and aesthetics, it leveraged an assault on this entire romantic tradition, one that nonetheless continues to inform cultural theory, art history, art criticism, and the ongoing debates between art and science and the humanities and quantitative analysis, which C. P. Snow identified in 1959 as the "two cultures" divide. Today this polemic endures through such paradoxical terms as "new media art" and in the challenges faced when discussing machine-generated color in aesthetic and philosophical terms.

Rationalization of the Artist

As early as antiquity, Plato determined a rubric for debasing the status of the artist who was, he argued, in the business of fabricating illusions. Painters "deceive with color," and thus they have a tendency to incite wild, irrational emotions in audiences that would threaten the future of the rational State. The term *techné* is used to denote art practices as well as craftwork. However, *techné* as craft is superior to *techné* as art because, Plato argued, artwork (primarily poetry and painting) could advance false claims about reality. Craftwork, however, such as bed making, was merely the practical application of a science that did not deviate from the notion of a true or authentic bed-Form. Under this logic, artists were banned from the Republic.[8] Just as it was for "color" in chapter 1 and "technics" in the introduction, "art" is here made secondary and subordinate to the so-called primacy of Form.

Jumping ahead, in the nineteenth century, industrialization and mechanization meant that machines could be programmed and automated to relieve

the craft-worker from performing mundane labors. Artisans and artists were "free" to create, not forms or things, but analytic structures that could be manufactured more precisely by technical devices. Notions of pure artistic "intentionality" became manifest as the genius-artist's "original" ideas sprang forth from his divine subjectivity. Meanwhile, craft-making's technical work was downgraded to a form of redundant manual labor, no different from or more intelligent than the machine itself. Industrialization thus inadvertently provided the preconditions for a return of romanticism for the artist-genius.

In turn, Walter Benjamin celebrated a new freedom and set of liberating possibilities for machine-made art. Film and photography, he argued in 1936, could be used to disarm the lofty pretensions of Romantic cult value and hermeneutic criticism surrounding art practices, liberating it from a depth model of contemplation and realm of "beautiful semblance." The new machine art meant a radical escape from mimesis into new experiences rooted in human-machine "innervation," beat to the lively mechanical rhythms of distraction and absorption.[9] Building on this approach, machine and computer automation in the postwar period were seen to offer a different kind of "freedom" and liberation: an *elevation* not of the artist, but of the *machine*, to something akin to the status of Plato's ideal and abstract Forms. For the proponents of this school, namely the German computer artists and those in related art movements, the new art made from computers was deemed completely calculable and precise, and therefore capable of a newfound aesthetic intelligence. The "computer could now find the regularities, patterns, evaluations, [and] speeds . . . of works," explained Herbert Franke, thereby freeing man not only from hours of tedious and redundant labor but also from the labor of aesthetic analysis and interpretation. Computers, he argued, could be used for automated art-making and aesthetic critique! Once equipped with a computer, one could achieve an automated "scientific theory of art."[10]

Heidegger and Cybernetics

Contra Benjamin and the advocates of a scientific theory of art, Martin Heidegger, as noted, maintained a more conservative view of machine automation and its implied techno-utopias. In his early work he mourns the loss of color that only "shows itself when it remains undisclosed and unexplained." Or, as I note above, the romantic notion that color "shines and only wants to shine."[11] Heidegger's antiscientific and seemingly cynical views of science and technology are, however, often overemphasized in accounts of his work. One must also remember, as Heidegger himself claims, his evaluation of technology is in itself neutral. His seemingly dark and pessimistic statements about it arise from *actual uses and applications*, uses that have, as it turns out, grown increasingly narrow and restrictive. Moreover, this has occurred, it is crucial to note, *historically, by way of human choice*, and not by some blind necessity

or mystical will of the hardware (the superficial definition of technological determinism). In other words, an intrinsically skeptical view of technology is not inherent to Heidegger's thinking.

Such is the attitude Friedrich Kittler takes in 2006 when he argues that the late Heidegger goes so far as to *embrace* science and technology. Kittler, who plays the provocateur that Max Bense did a few generations ago, argues that the late Heidegger presented an early model of cybernetic ontology.[12] In the late 1940s, Heidegger took a philosophical interest in new technical systems and was particularly intrigued by Max Bense and his research projects—especially in 1955, when Bense brought Norbert Wiener, the father of cybernetics, from the United States to Stuttgart and Ulm in Germany.[13] Kittler draws out the cybernetic language from Heidegger's late writings on technology, pulling quotes like "The energy concealed in nature is unlocked, what is unlocked is transformed, what is transformed is stored up, what is stored up is distributed, and what is distributed is switched about ever anew."[14] The late Heidegger, to Kittler's mind, wrote about systems with the zest of someone who had newly discovered the flexible brilliance of cybernetics, feedback circuits, and information theory. And it is true that when Heidegger writes, "[U]nlocking, transforming, storing, distributing, and switching [these] are ways of revealing," his terminology is very similar to Norbert Wiener's description of the processes of selecting, storing, and transmitting data in cybernetics.[15] Furthermore, because Heidegger's view of technics does in fact posit that technology "build[s] a way"—albeit a way that blocks—it *is* in a sense in line with Kittler's technical ontology and Bernard Stiegler's notion of *technogenesis*. (For more on this see the introduction.)

But to be fair, for Heidegger, Benjamin, and Wiener alike, the early applications of cybernetics and computer automation for bombs and death weapons were a far cry from anything celebratory, as the theory of rational aesthetics might suggest. Rather, the interlocking and automated control systems of cybernetics only intensified the "setting forth" that Heidegger warned against as the "supreme danger" of enframing in modern technology. Automation is a prime example of enframing because its purpose is to remove steps, and thus awareness, of the "how-to" in any technical activity. Further, the more automated a computer system, the more sophisticated its algorithms, and thus the less likely the average user is to grasp how and why things are occurring and operating the way they are. So while Benjamin celebrates the revolutionary potential of the new technology, he is also critical of its potential abuses, as noted in his discussion of fascism and cult value. In an early draft of his well-known essay on the topic, he is careful to assert that mechanically reproducible art must be used in the *service* of humanity, not to dissolve or eclipse it. He writes: "The representation of human beings by means of an apparatus has made possible a highly productive use of the human being's

self-alienation."[16] In other words, alienation *already* exists, and because film can isolate and emphasize this alienation, it therefore also has the capacity to bring alienated things and beings into a new proximity, to transform and transcend their alienation. The difference is subtle but crucial. So while Benjamin declared that machine art finally took traditional aesthetic values "out of the wrapper," he also feared that the total lack of wrapper could vanquish *all* critical distance and bring about hazards and ills, from physiological overstimulation, to propaganda, techno-fetishization, and a neo-romanticization of technology.[17] Paradoxically, what began as a celebration of the artist's freedom from physical labor and the demystification of art eventually resulted in a dangerous "freedom" from critical and political praxis. Enframing blocks us both ontologically and epistemologically.

Brave New Rationalism: Postwar Computing

Nonetheless, the reliance on automation and machine "intelligence" only grew in the aftermath of World War II, as massive research programs were launched to further develop computer-derived military intelligence and weapons systems. Alan Turing's theory of automata (1936) had already established that any process specified in a "finite number of logical operations" could be computed, a theory that provided the basis for much postwar research including Von Neumann's game theory (1944), John Nash's "Nash equilibrium" (1950), which demonstrated how a rational player, by employing appropriate rational strategies, could obtain maximal gains with minimal losses, and Ludwig von Bertalanffy's 1968 *General Systems Theory*, which marked yet another shift away from the mechanistic worldview of the classical sciences inaugurated by Newton.

Claude Shannon and Warren Weaver's *Mathematical Theory of Communication* (1949), as delineated in the introduction, announced the quantitative breakdown of organic communication systems, and Wiener's *Cybernetics* (1948) and equally popular follow-up, *The Human Use of Human Beings* (1950) theorized how the human, animal, and machine could be understood through information systems, probabilities, and feedback loops. In the new world of informatics and modern physics, particles assembled into patterns and electromagnetic waves into energy fields to make "sense" to machines more so than to humans. In contrast to the older Newtonian universe that ran like clockwork, the brave new world of cybernetics demonstrated that all was chaos until apprehended and sorted by rational ordering systems rooted in probability, statistics, and calculus.[18] Herein lie the postindustrial constituents of what I term the "algorithmic lifeworld" in the introduction and chapter 6.

As progressive visionaries, artists, and social theorists in the U.S. appropriated these systems theories and cybernetic models in art, intellectual

discourses, and new theories of the human subject in the 1960s, the new machine-automated art was brought into the public sphere. Gregory Bateson applied cybernetics to human ecological systems and anthropological analyses by mixing the worlds of the man and the machine, while American film scholar Gene Youngblood's *Expanded Cinema*, as noted in the previous chapter, offered a new theory of cybernetic art. Buckminster Fuller's futuristic geodesic domes inspired the counterculture and avant-garde architects to think in terms of systems, networks, and ecologies.[19] The electrified prophesies of Canadian visionary Marshall McLuhan—sprinkled throughout this book—attracted the attention of an entire generation. In 1968 the curator of the Jewish Museum in Brooklyn, Jack Burnham (who would later curate the infamous 1970 *Software* exhibition at the museum), argued in the pages of *Artforum* that cybernetic ideas had infiltrated the art world. The new art, he explained, does "not reside in material entities, but in relations," which he dubbed systems esthetics.[20] Art too had become a system like any other phenomenon, within which audiences and machines became synchronized and co-productive, dynamic elements.[21]

This ecological and humanistic approach to computing was however for the most part *absent* in early German computer art. At the same time, because many of the first generation of German computer artists and theoreticians regarded computing machines in literal, rational terms, they gleaned insights into aesthetic computing that many Americans missed. A closer look at these two divergent styles helps to reveal these distinctions.

Information Aesthetics

In Europe, ideas about information theory and cybernetics had been circulating for at least a decade prior to their arrival in the United States (figure 3.1). In the late 1950s, both Max Bense in Germany and Abraham Moles in France, while working separately, founded information aesthetics. Through the 1960s, the term "had a very precise and . . . formal meaning . . . the application of information theory to issues of aesthetics."[22] The information aesthetics of the 1950s must be clearly distinguished from information aesthetics today, which is concerned with data visualization, while the former is a rhetorical term used to critically explore and challenge the computational issues surrounding the bracketing and optimization of data in visual art. While Bense's role in the development of information aesthetics and the Programming of the Beautiful is the focus of the current discussion, Moles also made significant contributions in the French context. With the advent of the printing press, Moles argued, communication became "material." In other words, the sheer quantity of symbols produced could be subject to quantitative analysis like any other empirical phenomenon. These material signs could be measured, arranged, and composed regardless of their ideational content.

While text and music are abstract and symbolic notation systems that have existed for thousands of years, and in some ways lend themselves to certain kinds of a posteriori quantification, the difference between text and music on the one hand and computer notation systems on the other is that with computing, a *two-tiered relationship between code (symbol) and interface (image) is for the first time introduced to visual art.* To further understand the nature of this intervention, I borrow from American art critic Nelson Goodman's notion of the *autographic* and *allographic*, a theory that builds on the elevation and separation of the analytic and technical processes in art making. 3.1

An artist creates an autographic artwork in a singular act of creation, such as a painting or novel. In contrast, creation of the allographic artwork is two-tiered. In an allographic art form, like music composition, a written score or notation system forms the first stage of production and the performance of the music forms the second stage of production, or the end product.[23] The allographic is an especially useful concept within the framework of computer art and machine aesthetics because, in computational terms, the allographic artwork requires initial preparation—programming—and then a second stage of translation from the notation into the performance of the final work, or what is referred to in computer processing as the rendering of machine code into a visual display, or "interface."[24] It is in this initial stage of programming that information aesthetics thrives, a practice largely informed by precursors in the (also) predominantly German school of experimental aesthetics.

3.1 A group of artists, critics, and a general audience at the Werkstatt Breitenbrunn Gallery in Austria in 1968. "This picture shows how computer art was accepted in Europe early on," Frieder Nake explains, "in small circles of constructivist artists." Courtesy of Frieder Nake.

Experimental Aesthetics

Experimental aesthetics developed through nineteenth-century psychophysics, mainly through the work of German experimental psychologist Gustav Theodor Fechner,[25] who took his lead from the work of German psychologist Adolph Zeising. Zeising followed the thesis that the numerical relation of the golden mean was an a priori universal principle of harmony in nature and art.[26] Fechner took this claim and attempted to prove it within the context of psychophysics, which he did and published in his 1876 *Vorschule der Aesthetik*. Experimental aesthetics thus involves the quantification of perception, achieved by measuring human physiological responses, which are then used to extrapolate and construe so-called universal aesthetic axioms of truth and beauty. In short, a so-called perfect work of art becomes possible by way of mathematical proof.

In the nineteenth and early twentieth centuries, experimental aesthetics was taken up by philosophers Charles Henry and Charles Lalo. Henry's research on the subject, especially his *Sensation et énergie* (1910) had a substantial effect on art movements, including Purism and Neo-Impressionism. Henry classified all sensory experience in terms of stimuli that could be interpreted through quantifiable algebra. He, like Zeising, went so far as to argue that there was an underlying formal mathematical basis to all humanity, so that when one saw a perfect form, a sort of universal bell of ideal beauty would ring. Henry writes, "[W]hat we in psychophysics refer to as 'stimulus' is only a perception, but it is a special perception, a sign that one can take as a constant. All our knowledge is based on perception."[27] In short, once again it appeared that subjective perception could be measured in order to quantify and reproject "data" to a corresponding "perfect" shape and set of external forms, deemed universal and constant.[28]

Rational Aesthetics

Following in the tradition of experimental aesthetics and the work of the nineteenth-century scientists Hermann von Helmholtz and Fechner, in 1933, American mathematician George David Birkhoff attempted to further standardize aesthetic perception through quantification. Like Baumgarten, Birkhoff believed that aesthetics was a science, but for him, it was a science of feeling. If particular objects could be determined and correlated to feelings then "the aesthetic evaluation of [a] work of art" could be resolved through "reliable [and] objective . . . [set] of rules" which in turn could be mobilized as system of control in visual communication.[29] Birkhoff in fact claimed to have determined such a set of rules. He argued that order (O) stands in direct relation to aesthetic pleasure (M), in an inverse relation to the complexity (C) of the art object. The equation $M = O/C$ denotes that the "most beautiful of a class is that which exhibits as much order and as little complexity as possible."[30]

He constructed a formal economy for optical stimulation and response that could be used to achieve the "happy feeling of associative cognition."[31] For him, beauty consisted of perceptual *efficiency* in capturing and processing transmitted information. But a familiar problem arises herein.

Concepts like "meaning" or "purpose," normally given great emphasis in aesthetic theories, here become "units of measure." This is ultimately the same move that occurred in Shannon's 1948 information theory, an analytic approach that, as I note in the introduction, also quantified data within a communication system to sever any link to context. For Shannon and Weaver information "must not be confused with meaning . . . In fact, two messages, one of which is heavily loaded with meaning and the other of which is pure nonsense, can be exactly equivalent."[32] Likewise, for Birkhoff, "the quantity of information indicate[s] the complexity of a message," and thus the value of a work of art, irrespective of semiotic or contextual factors.[33] The same critique of cybernetics offered in the introduction and of psychophysics in chapter 1 applies here.

Rooted in the semiotics of Charles Morris and Charles Peirce, yet also strongly influenced by Birkhoff, Max Bense also aimed to standardize formulas for the systematic interpretation of "signs" in computer art. Bense took Birkhoff's formula, discarded his concern with subjective perception, and combined it with Shannon's theory of information. Where Birkhoff's aesthetic measure was "a function of order and complexity," Bense "replace[d] the complexity *C* with information *H* of the selected signs and replace[d] order *O* with redundancy *R*."[34] Because redundancy is a repetition, originality and innovation therefore emerge from a rupture in a pattern, i.e., new information, noise or disorder, within the system. While these formulas may appear to bring a certain kind reliability to aesthetic judgment, they systematically ignore the ethical and practical problems in quantifying art and poetic thought, not to mention the specificity of an artwork's reception. At the same time, these concerns are precisely what Bense's project staged as a part of its ideological and aesthetic critique.

Quantifying Computer Art

Bense began lecturing on information aesthetics and generative art at the Stuttgart Technological University in 1957. Frieder Nake, a pioneering computer artist and former student of Max Bense, recalls that during these lectures Bense would "regularly use the seminar room to put up exhibitions of concrete and constructivist art and poetry, typography, and generally experimental works." On February 5, 1965, a visitor to the class, Georg Nees, displayed some of his computer art on the walls of the lecture hall. Two of the works, *Andreaskreuz* and *23-Ecke*, were composed using ALGOL 60, on Konrad Zuse's Graphomat Z64, his last commercial product.[35] One of Bense's students, an artist, reacted:

> "Tell me, Mr. Nees, can you make your machine draw like an artist's flow?" Nees ponders for a moment. He is a calm, patient, friendly mathematician of about 35 years of age. Then he says, "Yes, I can. If you can tell me precisely how to define your way of drawing."[36]

The student's question is emblematic of a wider reaction to automated work. The advent of computer art suggested that the genius artist could now be tinned in a can. Bense responded to his student's anxiety by assuring him, "It is only *artificial* art." But the idea of artificiality only intensified the controversies then forming in response to computer automation in art.[37] The threat of artificial art, Nake explains, is that it "questioned the much-cherished retreat: the artist's intuition and creativity."[38] Second, the term intentionally invoked the then current and equally contentious artificial intelligence research being conducted in government and military agencies. Artificial intelligence projects and their advocates, many of whom were based at MIT, purported that the computer could be programmed to think and act just as a human could, if not better. If this was true, then maybe computers could also surpass humans in art making?

The contentious computer images reintroduced the polemical question, "What is art?" Consider Bense's definition of the artwork as "a set of drawings . . . produced by an automatic drawing machine controlled by a program, run on a digital computer."[39] According to Bense's theory of information aesthetics, through computing, both art and art-making processes had been fully rationalized. In short, with computers, art had been subject to a Programming of the Beautiful.

Programming the Beautiful as Ideology Critique

After World War II, Germany faced an existential and intellectual abyss that Bense aimed to fill. Like Heidegger, he saw tragedy in the new world of technological rationality, bureaucratic ordering, and the economization of daily life. While they held dramatically different attitudes towards technology and the war, they nonetheless both recognized the ways in which technological rationalism had deeply penetrated modern life.

Bense's provocative move was to target the effects and hyperbolic reactions to this rationalization in the last stronghold of classical aesthetics and philosophical humanities: the concept of the artistic genius. "Rational aesthetics," Nake explains, was designed to "draw a line between itself and *non*-rational aesthetics," i.e., Romanticism or what one would call hermeneutics. He expands:

> [I]n the early 1960s . . . in Europe, aesthetics was to a large extent a discipline of interpretation . . . the freely and intuitively wandering mind that allowed itself

> any freedom to say this and that . . . and soon would be talking about god and the world, and claiming this was all about the aesthetics… So the starting point for rational aesthetics was a discontent or even discomfort with an approach to painting that was more interested in the history and psychology behind the work than with the actual appearance in terms of material, form, color etc. of that work.[40]

The project for rational aesthetics aimed to effectively disfigure the sacred altar of interpretation, intuition, and the "genius" of art-making, laying them out to dry as allographic works that consisted of a mere selection of elements from within a given repertoire of choices that the computer then executed into an image.

Second, Bense's provocations, like Kittler's, functioned indirectly as a critical performance. For example, Bense found that the moral lesson to learn from the Nazi past was that anything that was not "accessible to rationality, not stochastically objective, was ideologically suspicious."[41] This is how and why his project for a Programming of the Beautiful offered a critical mimesis of the Nazis' distorted glorification of rationality and science. The project for a rational aesthetics was a genuine attempt to "demystify" computer art; to "get rid of all the terrible ideology and to prepare for a world with as little ideology as possible."[42] In this sense, which offsets the first, Bense's provocative and performative rhetoric attained a critical edge as it shored up the absurdity of rational autonomy by placing it at the center of art making. Such subtle ambivalences and playful stabs at ideology, unfortunately, continue to cloud the reception of Bense's and Kittler's discourses in the U.S. The Programming of the Beautiful must therefore be understood as both an indirect critical discourse on rational society *and* as a way of transforming traditional aesthetic values and hermeneutic methods to instead work in tandem with the materiality of new technologies, just as Benjamin attempted in his celebration of mechanically reproducible art.

Bense's program also provoked questions about social subjectivity and the way in which it was increasingly produced through numbers and rationalized thought. Statistics, Bense argued in the 1960s, was "the only way to approach a new being." Being was increasingly dissolved in and through what Bense termed a "sphere of technical being," which made individual and subjective aesthetic interpretations irrelevant.[43] The ongoing resistance, denial, and dismissal of both Bense's and Kittler's ideas (and Stiegler's for that matter) confirm that many—at least in the U.S.—are still heavily invested in romantic beliefs about human originality, intentionality, agency, and autonomy in order to distinguish (and privilege) the human from machines. The provocations of Programming the Beautiful—that human genius can be quantified and art calculated—function to expose these pretensions in full detail.

Bense was not alone in his anti-Romantic, post-hermeneutic forays in techno-rational computer aesthetics. German information and aesthetic

theorist Rul Gunzenhäuser, for instance, who wrote his dissertation under Max Bense at Stuttgart University in 1962, also followed Birkhoff's approaches to rational aesthetics. Because his formulas functioned best when dealing with objects with high levels of abstraction from historical or semantic contexts, Gunzenhäuser argued that children's rhymes in fact had a higher aesthetic value than the "poetry of Poe, Coleridge, or Goethe." Stars, he argued, are superior to and more "beautiful" than irregular shapes because they are more mathematically sound.[44] Likewise German computer artist and proponent of rational aesthetics Herbert Franke argued that the degree of innovation in any artwork could be "measured with the help of *statistical information*."[45] Because the human brain retains "16 bits of information per second with a storage limit of 10 seconds," he contended, a successful computer artwork would only need to balance the amount of information transmitted. "[T]oo much order leads to boredom or alienation, while too much innovation is noise or disorder."

Through rational aesthetics, it was hoped, one had finally wrested "innovation" from its roots in the Romantic tradition and transplanted it into a new system of postsignification fit for the rationalized and automated postwar world. The Germans found a way to quantify both art and aesthetic perception. The dawn of computer art, in Germany at least, seemingly proved that mathematical measurements and statistics could indeed achieve a Programming of the Beautiful—efficiently and effectively organizing, sorting, and distributing electronic signals into art forms and corresponding aesthetic experiences.

Color as Number: Frieder Nake's Computer Art

Ideas about color underwent the same process of rationalization that transformed notions of the artwork and the artist in the mechanical age. In the long history of Western aesthetics, color is traditionally theorized as subjective, transcendental, and spiritual, and as such, it is deemed to be a phenomenon that cannot, or rather should not, be quantified or calculated. To re-cite Heidegger: "Color shines and only wants to shine. When we analyze it in rational terms by measuring its wavelengths, it is gone." As I discuss in chapter 1, this attitude is typical of numerous Western artists, critics, and artworks.[46] In contrast, in the history of aesthetic computing, color arrives as a discrete number and quanta *long before it emerges in sensual, visual form*. For this reason, the treatment of color as number in Frieder Nake's computer art helps to recapture the gravity of this historical moment and color's aesthetic transformation in it.

Frieder Nake began making computer art in 1963 (figure 3.2). In 1967 he created *Matrix Multiplication*, one of the few uses of color in computer art from this early period. To make the piece, he divided the space into four sections of a grid where each section "reflected the translation of a matrix [that] was multiplied successively by itself . . . .Each number was assigned a visual sign with a

3.2

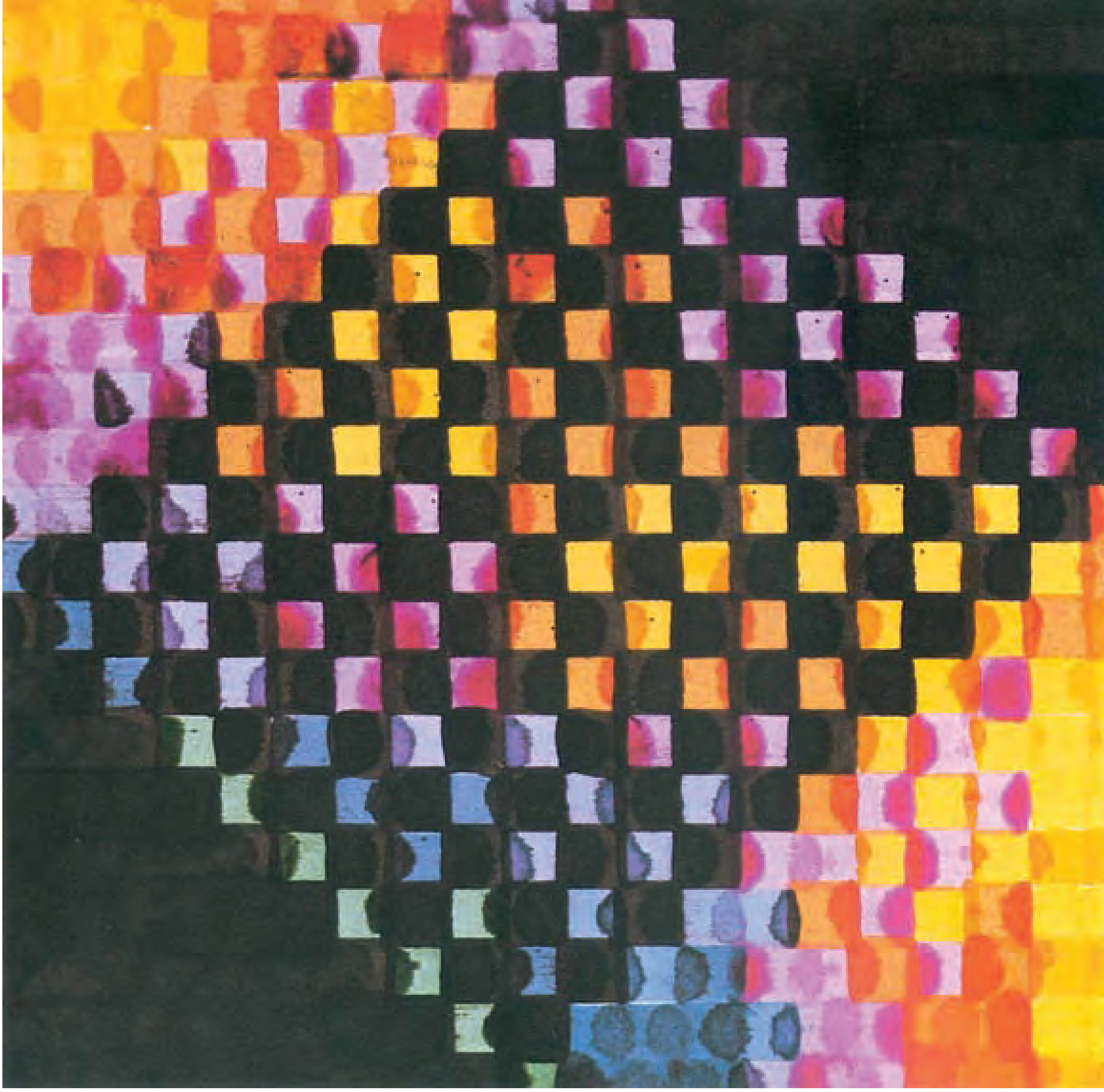
3.2 Frieder Nake in 1966: "The occasion is wonderful: a group of about 20 or more artists from Stuttgart... I am seen trying to sell computer art, moderately successful." Courtesy of Frieder Nake.

3.3

particular form and color."[47] He placed these value-signs in a raster according to the numeric values of the matrix, computed them on an AEC/Telefunken TR4 programmed in ALGOL 60, and then plotted them with the Graphomat (figure 3.3).[48] He describes the process of producing color in detail:

> [T]he computer, under the control of my programs, determined all the necessary movements of the drawing machine later on. Its output was a paper tape. It contained an exact coding of each and every detail of the drawing. This coding typically consisted of commands of the following simple type: move to (x, y); pen p down; pen q up; stop. The paper tape was then taken to the drawing machine where it became the input. The control unit of the drawing machine interpreted the coded commands so that the step-engines moved the drawing head with its pens according to the speeds currently requested. A single line element could be as short as 1⁄16 mm (this corresponds to the resolution) . . . .So the computation only knew there is color no. 1 and color no. 2. It had no idea of what these colors looked like.[49]

Color was programmed into the system from the start. Yet what was actually programmed was not color, but number. Arbitrary and nonvisual—these numbers were placeholders for any color or variable. The set of numbers, basically an algorithm, had no continuous or indexical connection to the actual output color. Moreover, because the colors were interchangeable the process could "result in a different choice of the color set now and tomorrow" (figures 3.4 and 3.5). When reprogramming *Matrix Multiplication* in 1970, Nake explains, "instead of short strokes in color" he used "certain elementary symbols as output [that] encoded grey values." This is echoed again with his 1967 tech-

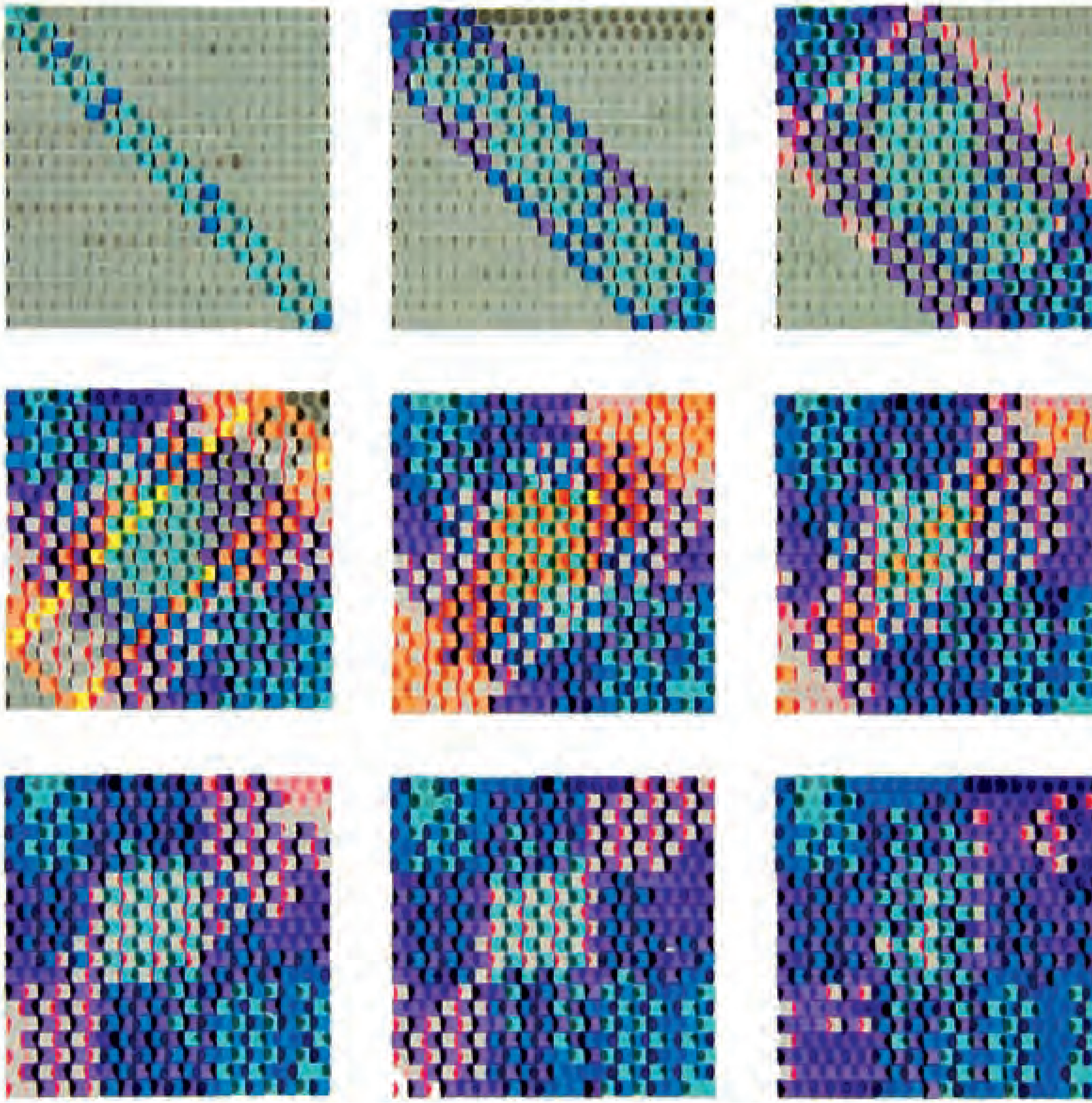


nique, where "signs were arranged . . . as symbols chosen from the typewriter. A code would say that * was red, + was yellow, # was blue etc."[50] At this early stage, computer color was limited to numbers, organized in algorithmic codes, and designated in the initial stage of conceptualization long before color ever appeared in visual or sensory form (figure 3.4). 3.4

Nake's innovation was to use color in computer art when color was not yet conceivable. While the condition of color as number is still the condition of color in computing in general, the difference is that today an artist or computer user selects colors *visually* (one need only point and click on a purple swatch to fill a shape with that color) or by a code, but a code that already corresponds with a set color (for instance 4CBB17 is the HTML code for a Kelly green). Nake did not have the benefit of this kind of automation. Instead, he selected

< **3.3** Konrad Zuse's Graphomat Z64. An early "plotter" for printing computer-generated digital graphics, developed in 1961. Courtesy of Frieder Nake.

3.4 Frieder Nake, *Matrix Multiplication* series 3, 1967. China ink on paper, 50 × 50 cm. Color was added in postproduction but programmed in advance as a number. Courtesy of Frieder Nake.



3.5

colors rationally and analytically—through mathematical programming, using a pencil and graph paper and a numerically based notation system that he then translated into additional variables for the plotter's output. His work serves as an important predecessor in this history because his methods and procedural logic constitute the inverse—but material base—of what has become the fully automated digital color picker. Today the fact of digital color as number is hidden—naturalized through the interface—and thereby rendered invisible.[51] (figure 3.5).

Computer Art Beyond Germany

Despite this chapter's narrow focus on computer art from Germany and the U.S., the origins of early computer art are hardly restricted to these regions.[52] In recent years a significant amount of research has emerged covering the early years in multiple contexts and in relation to different art and technology movements. For example, in the British context, there is the edited volume *White Heat, Cold Logic*[53] complemented by a large edited volume on computer art in relation to the New Tendencies movement (1961–73), which is geographically linked to Zagreb in Croatia, the *Bit International* journal, and such art groups as the Italian Gruppo T, Groppo N, Enzo Mari, constructivism, the Paris-based Groupe de Recherche d'Art Visuel (GRAV), and Bruno Munari's developments with *arte programmata*.[54] Like Bense's project, these cohorts and movements sought to establish a new position for art that distinguished itself from the art of the past, namely from Abstract Expressionism and Tachism. The New Tendencies group in particular aimed to replace the old art with a "methodically planned artistic practice" that was, as Margit Rosen puts it, "oriented on procedures used in science." The brush was "passionately banned from the studio" in favor of using the computer and mathematical principles to create "programmed painting." Because programmed art was reproducible and multiple from the start, proponents of the movement argued, it would serve as an effective means of undermining the art market's evaluation of and esteem for "originals." Any trace of art's "sacral and aristocratic past"—what Benjamin called the "cult of beautiful semblance"—would "be erased."[55] The New Tendencies thus echoed and reinforced Bense's project and the general ethos of the German school, and in fact Bense's writings and Nake's and Franke's work were commonly included in the New Tendencies exhibitions and publications (see figure 3.1).

Additionally, there is French computer artist Vera Molnar, who is associated with the Groupe de Recherche d'Art Visuel (GRAV), American computer artist Roman Verostko, and German computer artist Manfred Mohr, all of whom worked in black-and-white during the 1950s and 1960s (though they later turned to color). So while their work is generally beyond the scope of

3.5 Frieder Nake, *Matrix Multiplication* series 34, 1968. China ink on paper, 50 × 50 cm. Courtesy of Frieder Nake.

the current analysis, their pioneering contributions to the field, and consistency with the rational approach I have been describing thus far, nonetheless merit a brief note before analyzing the use of color in the work of pioneering Dutch computer artist Peter Struycken and then turning to the U.S. school.

Molnar's *Squares* (1974–75), for instance, consist of a series of black-and-white computer-generated shapes and lines. In order to create the images, she began with an initial array of square elements and then systematically altered the dimensions, proportions, and number of elements, including their density and form, to predict and challenge how her formal modifications would alter the image's final reception. "My computer-aided procedure is only a systematization of the traditional-classic approach," she explains; "the use of the computer in art is an important tool for the working out of a 'science of painting'" and more generally "a 'science of art.'"[56]

Likewise, German-born Manfred Mohr, who was also a proponent of Bense's information aesthetics, argued, "through detailed programming analysis, one is able to visualize logical and abstract models of human thinking, which lead deep into the understanding of creative processing."[57] Mohr began working with computational aesthetics in 1969, after studying in Germany and at the École de Beaux-Arts in Paris. In 1971 he exhibited some of his work at the Musée d'Art Moderne de la Ville de Paris in one of the first museum displays of artworks entirely drawn by a digital computer (entitled *Manfred Mohr: Computer Graphics—Une Esthétique Programmée*). Mohr has since been recognized as one of the founders of software art and generative aesthetics. Roman Verostko also produced early computer artwork using methods akin to Molnar and Mohr, that is, markedly rational and formal techniques to explore line and shape, with or without color.

It is also worth noting that these aesthetic styles, informed by constructivism and formalism, became characteristic of the first generation of black-and-white computer art in *both* the U.S. and Europe. For example, in the early computer artwork produced by Bell Labs' engineers and pioneering computer artists A. Michael Noll and Ken Knowlton, as I analyze in the next chapter, one finds *only* clean black-and-white lines and shapes, arranged in geometric configurations.[58] There are many other examples of pioneering work produced in black-and-white during this time, and while my primary concern here and throughout this book is with color, it would be negligent to deny the prevalence of this early aesthetic and the ways in which this austerity and hard-edged minimalism came to characterize the first generation.[59]

To a large degree this characterization occurred for technical reasons. That is to say, out of necessity: the rudimentary platforms and primitive rendering algorithms used to produce these images were at first capable *only* of rigid lines and hard edges. Moreover, black and white were not color choices, but rather default settings. And again, bear in mind that these programmers

and artists often had to write the programs and at times build special modules for a computer system before they could even begin to program an image. Such technical challenges remained in place until developments like the frame buffer (chapter 4) and the alpha channel (chapter 5) in the early 1980s, both of which coincide with the development of the GUI and rise of user-friendly digital color. Thus, even if color was used or somehow integrated into these early digitally generated images, it almost always appeared as secondary; a supplementary add-on in relation to the visual dominance of hard black-and-white forms, generated on a vector screen or raster grid. It should also come as no surprise that the dominance of line and form in this early work reflects cultural values rooted in Modernism, Western chromophobia, and the long history of *disegno* in art making, bolstered by the hyperrational and techno-scientific origins of computing and modern culture. And herein lies another reason why the subject of color has been marginalized (prior to this book) in an otherwise overwhelmingly black-and-white history of early computing.

Color Balance: Peter Struycken

As a segue between the rational approaches to color in the early German computer art noted above, and the mystical approach characteristic of the U.S. school, one finds a slightly more balanced approach in the work of Dutch artist Peter Struycken. Born in 1939, Struycken worked with color across multiple disciplines including architecture, costume design, theatrical decor, and computer art.[60] I here limit my comments to his early experiments with color in computing.

Struycken studied painting at the Royal Academy in the Hague from 1956 to 1961, where he explored various media; but regardless of platform, his interests always returned to notions of "coherence and variation" in color.[61] In 1964, he wrote: "My aim is to show that shape and colour can be mathematically linked, not only creating a maximum degree of unity but also making the mutual relationship between shape and color computable."[62] To be sure, his interests in rational color were suited more to computation than to painting, so it is no surprise that he migrated to the medium in 1968, when he began working with a computer with 4 KB of memory at the Institute for Sonology in Utrecht.[63]

When the Prince Bernhard Culture Fund commissioned Struycken in 1969 to investigate how science and engineering students could benefit from design, he used the opportunity to explore what one now calls digital "data visualization."[64] However, until he could access a computer-controlled color monitor on a regular basis, his data visualization methods involved transcribing the computer's results into another medium. For instance, by converting the coded computer output to punch tapes (a series of open and closed punched holes on paper that corresponded with the patterns) that were then played in a light

box like a film, one image at a time, or alternatively, by transferring the output to a static medium like painting, and then rendering it in color.[65]

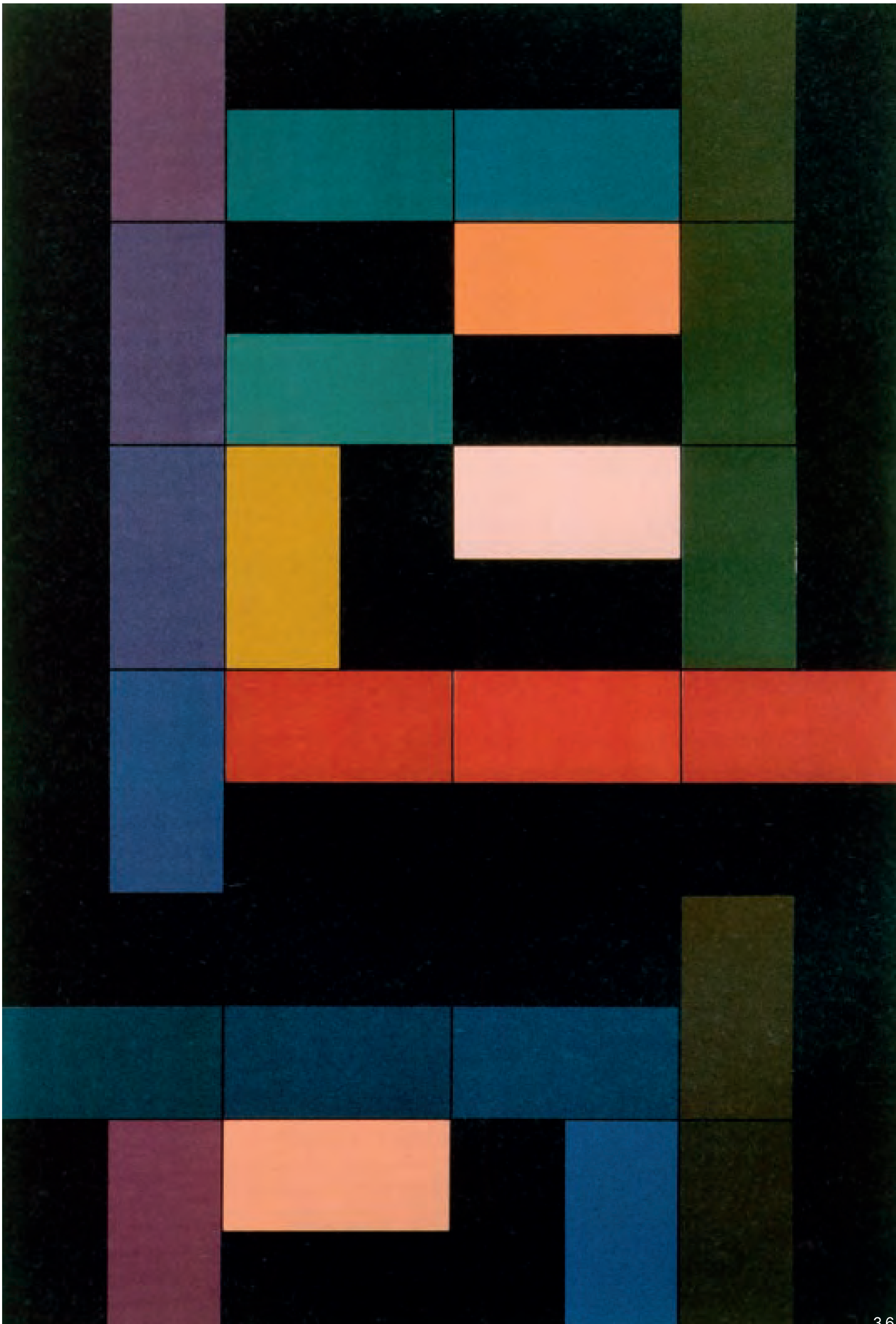
Unlike the romantic approaches to color that then saturated the European academy (Goethe, Itten, Kandinsky, and Hirschfield-Mack), Struycken's approach to color was, to a large degree, like Bense's and Franke's. In his own way, Struycken set out to program the beautiful by drawing on the work of Richard Paul Lohse and De Stijl's Theo van Doesberg (who also subjected color to mathematically determined proportions).[66] The influence of these artists can be seen throughout Struycken's work, especially in his use of the computer medium (figure 3.6). For example, *CLUSTER 16*, developed with Stan Tempelaars and made between 1971 and 1975, consists of a series of paintings documenting the variations of a computational principle based on the regulated inclusion and exclusion of preselected elements. Struycken placed twenty-four colored elements on a plane with half of each element colored black. Together the elements formed a square, arranged according to the logic of a color circle with "optically equal intervals." Using a series of algorithms similar to those used by mathematician John Conway in his 1970 Game of Life, he programmed the computer to place the elements in a rectangular field. Jonneke Jobse explains *CLUSTER*'s programming logic:

> [T]he elements had to link up in the same position as in the square figure. Thus, when an element landed outside the field, it had to be placed on the other side of the requisite position, so that the ordering could continue according to the same principle. However, because only one element was allowed per place, new problems constantly arose. Every time an element landed on a place already occupied, the computer had to solve this by choosing another element, skipping a few places, or starting the sequence again.[67]

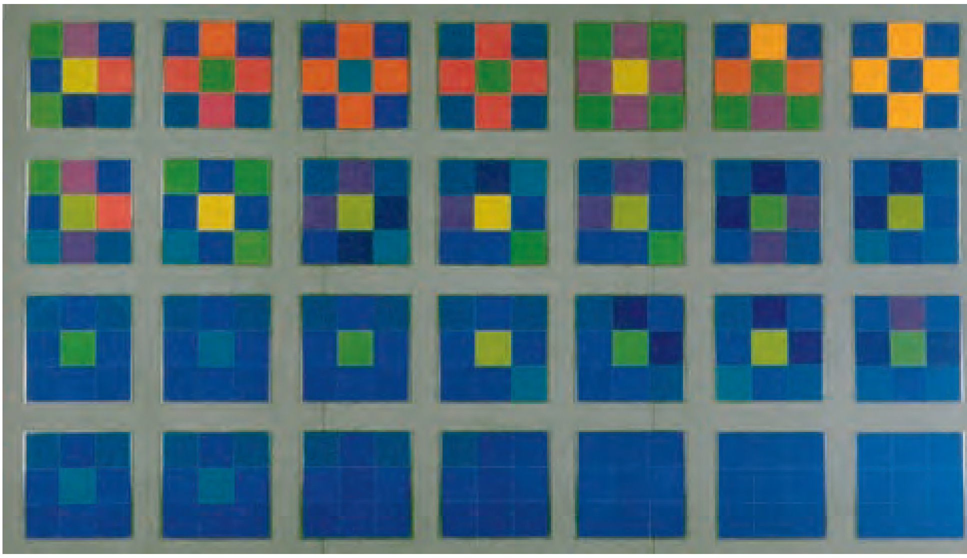
CLUSTER created a precise order for color but also, a color world that was arbitrary and a mere instantiation of a mathematical equation.

As a result of networking and collaborating with C. Wissenburgh, a graduate student in electrical engineering at the Delft University of Technology, in 1972 Struycken gained access to a color-controlled computer that he used regularly one night a week.[68] Wissenburgh set up the color monitor system, and G. van der Wal, an associate of the graphics group of the Delft Computing Centre, wrote the initial programming for the PDP-15 computer.[69] With the color computer he found that color blending possibilities were "virtually unlimited" and enabled him to "structure and visualize colour changes in time and space."[70]

In 1972, Struycken made *PLONS* (in English *Splash*, 1972–74), for which he for the first time wrote his own computer program inspired by the "splash" pattern of concentric circles made when an object is thrown into a still body of water (figure 3.7). He programmed a set of colored squares, selected from a circle of twenty-four, to continually change values until they reached a



3.6 Peter Struycken, *CLUSTER 16*, 1971–75. Enamel on Perspex, 200 × 120 cm. Collection of J. and M. Eyck, Wijlre, Netherlands. Courtesy of Peter Struycken.



3.7 predetermined pattern. At the point where a color change became perceptible, it was allotted a numeric value and a new color would replace the old one. The result was a series of “color patterns which had undergone exactly the same changes as the numbers in the computer program.” The system allowed the interface to mirror the code in a one-to-one correspondence.[71]

Onscreen rendering was at the time extremely limited but, as a testament to Struycken’s ingenuity and innovative spirit, he found a way to work around this. In Impressionist style, he used tiny colored dots to render his images. Color was used constructively to create a sense of shape, line, transition, and nuanced space.[72] He employed this technique throughout the late 1970s, with colorful works like *LINE 1,2,3* (1977) and in the 1980s, when color in screen-based work became more feasible, as I discuss in chapter 5. Also significant is the way in which this work introduced an experimental and creative alternative to the austere and geometric black-and-white aesthetic noted above. Struycken eventually went on to work with 3D color design and architecture but his enthusiasm for the mathematization of color remained intact. In 1999 he professes, “[i]t is amazing, marvelous and simple to be able to use a single type of mathematical function for the arrangement of colours in space and time.”[73]

Struycken is a valuable figure in this chapter because his use of color in early computing is both practical (designed for visual pleasure) and formal (mathematically dense and systematic). Carel Blotkamp argues that it is a mistake to view Struycken’s work as exclusively “rational [and] intellectual” because it is really more concerned with “sensory experience.”[74] And indeed, in 1992 Struycken writes, in John Ruskin style proper: “I want to see colour as a phenomenon without pre-established value or meaning . . . Approaching color in a manner free of values means that it can be viewed without prejudice.”[75]

Certainly this attitude supports the “innocent eye” sentiments noted in the previous chapter, and in this way Struycken’s colorism is unequivocally poetic. But also, as I note above, his colorism is undeniably scientific and mathematical. In fact this rationalism needs to be reemphasized, given that he was trained as an artist and only later crossed over to programming, unlike many of the European practitioners noted above who were trained as programmers and mathematicians and later decided to apply their science to art.

Moreover, while Struycken was heavily influenced by nineteenth- and twentieth-century research in optical perception, his style and color treatment never veered too far into these metaphysical or mystical traditions, as many of his art world contemporaries did. For him, “organization and design” were required to “consciously experience a visual image.”[76] Or, as Jonneke Jobse points out, “like Pythagoras,” Struycken “believed that true beauty reveals itself in the laws of number.”[77] This shows a respect for number but less concern with the cultural or symbolic attributes of art or color. In short, his interests lay in the ways in which mathematics and order could be used to heighten aesthetic experience. For Struycken, Blotkamp writes elsewhere, “a line is not a carrier of cosmic energy, but a dot which is continually shifting; colour has no power to wound or heal, but exists solely in distinction to other colours.”[78] In sum, Struycken’s use of color in early computing falls somewhere in between the Germans’ rational approach and the more traditional and qualitative concerns with poetic color in aesthetic experience that, as I will now show, characterize the U.S. school.

Subjective Color in Early Computer Art: The United States

In the United States, color in early computer art functioned in an entirely different way than it did in the German and broader European contexts discussed above. At this early stage in American computer art, thinking about color *as a number* was actively avoided. Even some of the most cutting-edge technological works stopped short of emphasizing color’s numerical status. Instead, a number of American artists saw color as an aesthetic pleasantry, a means for emotive expression and utopian symbolism. As noted, intellectuals and philosophers like Marshall McLuhan, Gregory Bateson, and Buckminster Fuller promoted ideas of symbiotic relations between humans and machines in the new electronic global village, which a number of American computer artists reflected in their use of color. In contrast to the German approach, Frieder Nake explains, the “American/Canadian approach was without theory. Just play, do your thing, be creative, do something exciting.”[79] In this section I discuss four key examples of this approach in the work of John Whitney Sr., Ben Laposky, Mary Ellen Bute, and Stan VanDerBeek, though other examples from chapters 2 and 4 may be invoked.

3.7 Peter Struycken, *PLONS 220273-2B* or *Splash*, 1973. Silkscreen on paper, collage, 40 × 40 × 28. Depending on the number of steps the computer needed to achieve the final state, the output images could be longer or shorter. *PLONS 220273-B* is one of the longest of the series because every color combination yielded a different visual effect. Collection of the Central Museum, Utrecht, Netherlands. Courtesy of Peter Struycken.

American experimental filmmaker and eventual computer programmer John Whitney Sr. made pivotal contributions to the history of computer art, abstract cinema, "visual music" (computer-generated visual graphics orchestrated to music) and multimedia displays, such as the large-scale multiscreen collaboration he developed with Charles and Ray Eames for the Moscow World Fair in 1959. During World War II Whitney worked at the Lockheed Aircraft factory in California, where he observed how antiaircraft missile computing systems could be used not as a weapon of war, but instead to produce clean and abstract geometric forms for computer-generated graphic art. When the war ended, Whitney began to collect "mechanical junk excreted from army depots across the country." These efforts yielded surplus technology left over from both world wars, including items like a brand-new "thirty-thousand dollar antiaircraft . . . analog ballistic problem solver computers."[80] His scavenged M5 Antiaircraft Gun Director was a mechanical analog computer originally developed by the British for the guidance and control of antiaircraft guns and related weaponry. The American adaptation of the system, the M5, was the one Whitney purchased.[81] With this bulky computer system, weighing approximately 850 pounds and consisting of over 11,000 parts, Whitney developed a sophisticated and systematic motion control system that he named his "cam machine." With his cam machine he learned how to create colorful experimental computer art and visual music.[82] Throughout the 1950s he used the system to help realize, as Youngblood puts it, "certain graphic possibilities that might otherwise not be conceivable to the artist untrained in mathematical concepts."[83] His results became some of the first computer art films that, over half a century later, remain elegant and beautiful.

To begin solving the complex visual problems he encountered in graphic computing, Whitney envisioned a "field of action" or a "gestalt pattern of moving elements."[84] When it came to color, his approach was equally poetic: "[T]he transiency of color," he wrote, "lies open to exploration." The only problem was the technology, which could get in the way of these poetic goals:

> One propounds theories for the use and effect of color . . . Color for the painter is normally an intuitive experience of direct one-to-one interaction between three components—pigment, hand and eye. These intimate hands-on interactions call upon a part of the creative mind other than the reasoning channels needed to work creatively with color film. My efforts to achieve painterly control of color film processes were too often frustrated. Lab and printing stages interpose processing time as a kind of insulation between the intuition of the moment and the actual color effect.

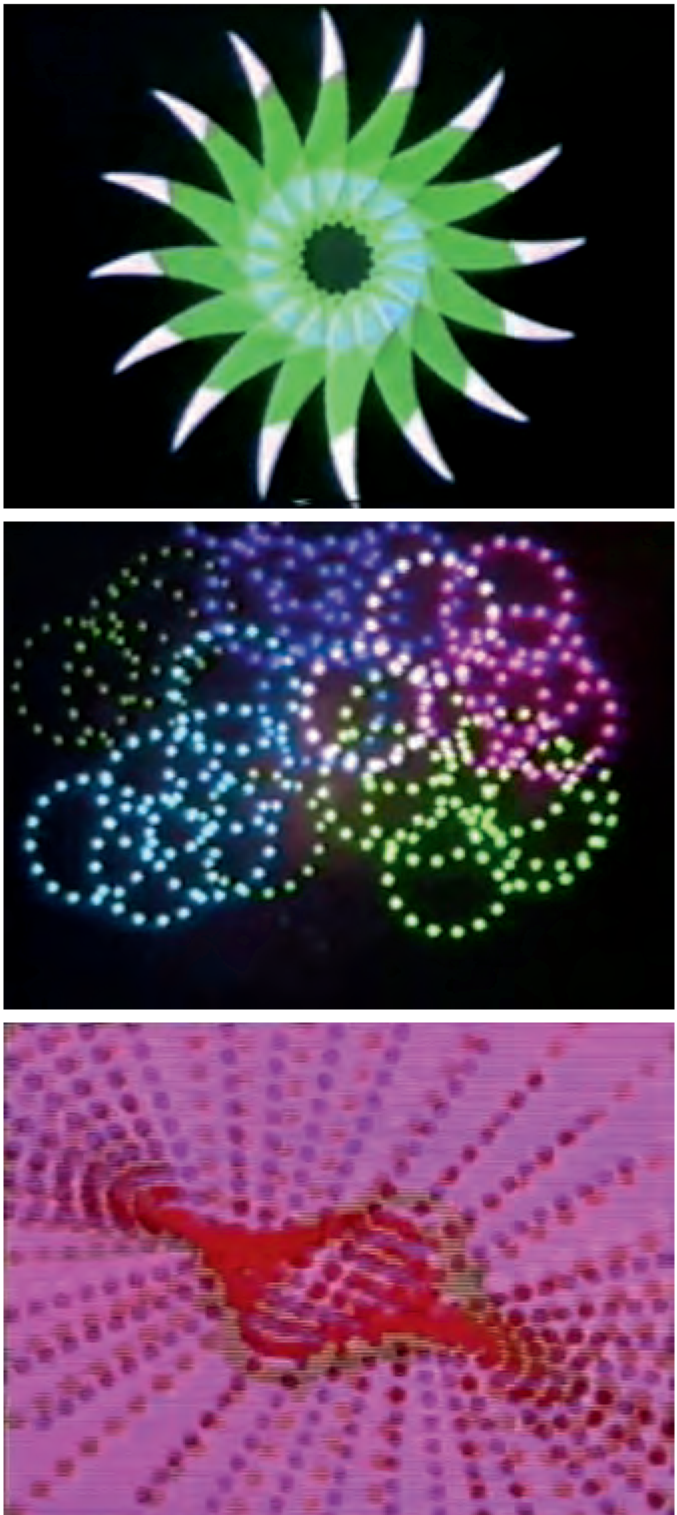
Whitney wanted to use color intuitively and he saw a future for this in video (a future defined less by subjective and more by "dynamic" and "controlled" aesthetic sensibilities,[85] and indeed, as I will show in chapters 6 and 7,

this controlled, nonsubjective use of color is exactly what characterizes colorism in new media art in the 2000s). At the time, however, this remained an unrealized vision. Whitney's color techniques, while subjective and romantic, were also highly systematic and rigorous. Because each plot or colored dot in each frame of the computer film represented the calculated lead time necessary to fire and successfully hit a moving target, Whitney had to calculate each of these ballistic values before applying the color.[86] But regardless of this rational and computational requirement, in the end his colors, thematically speaking, remained more concerned with visual beauty and *poiesis*. In sum, his work complements the then expanding experimental cinema introduced in the previous chapter and its associations with a mystical transcendence of technology *through technology*.

Whitney's life-long pursuit was to create what Mary Ellen Bute called "visual music," and what Whitney termed "digital harmony." He saw the principles of harmony, balance, ratio, interference, resonance, and rhythm as a composer would: as grammatical units that could be used to carefully craft a composition. "The art of music," he explains, "deals with the harmonic laws of physics." Visual composition is in this sense a science, but one always already subordinate to art.[87] Harmony, balance, and rhythm were systematically employed in the service of creating art, or, "visual harmonies . . . that the eye might perceive and enjoy."[88] In this sense Whitney's methods were similar to some of the above examples, the crucial difference being that color for Whitney was never theorized in the systematic and rational terms that is was in Struycken's, Nake's, Franke's, or Bense's work. Rather, for Whitney color was always a visual effect and mystical vehicle for a transcendental gestalt.

This mysticism was even more pronounced in the reception of Whitney's work. He never produced a finished computer film with his cam machine, only a demo reel that consisted of a series of luminous and beautifully colorful special effects referred to as *Catalog* (1961) (figure 3.8). Set to the soundtrack of Ornette Coleman, *Catalog*, Youngblood wrote in 1970, presents a "multi-sensory experience of flux and flow in colorful light images and tactile, visceral sounds," a series of "neon-like cold scintillations" that produce "patterns, colors and motions dancing . . . addressing the inarticulate consciousness with a new kind of language."[89] A new language indeed, one that had to work through rigorous calculations, informed by the guiding logic of a ballistic missile system, only to then renounce this complexity to highlight instead an "inarticulate" cosmic consciousness of color sensation.

A similar machine was produced and used by Whitney's brother, James Whitney, for his mandala-themed and equally intricate *Lapis* (1966). James Whitney worked at the California Institute of Technology during the war and was, like his brother, tuned in to the fusion of art and technology.[90] But again, this work's reception (with help from the title and soundtrack) speaks more



3.8

to a mysticism and technological transcendence than to the facticity of the machines or their hyperrational processes.

In 1966 John Whitney was invited to IBM as an artist-in-residence where he collaborated with IBM programmer Jack Citrom, author of GRAF (Graphic Additions to FORTRAN) (figure 3.9). Citrom was using an IBM Model 360 computer and 2250 graphic display console. Their screen display system was quite sophisticated for the time. The CRT possessed an addressability of up to 4000 by 4000 points, which allowed them to work in "real time." Whitney learned GRAF and stuck with it in his later films, including *Permutations* (1968), which also maintained the ethereal and poetic color associations of his earlier work, also by way of the same rigorous technical and computational color control.

3.9

In sum, Whitney's mystical colors are stunning and mesmerizing, but as they dance on the surface of the screen they also deny the rational and markedly computational nature that actively went into their production. Part of this is explained by the fact that Whitney's colors were not digitally computed, at least not at first. Colors were added in postproduction, using mechanically rotating color filters. For instance, *Catalog* was shot on black-and-white 35 mm film and the color was added later using an optical printer in Whitney's home studio.[91] Even with his later digital graphic film, *Arabesque* (1975), inspired by "the indirect meandering of the casual connections between Islamic ideas of cosmos, music, geometry, and architecture," Whitney produced the images in black-and-white and then edited and compiled the final cut in color.[92]

Another explanation is that for the works he made in the 1950s and early 1960s, Whitney used a mechanical and analog computer system, which means that input and output processes were calculated through continuous variables, not discrete units that converted data into 0s and 1s. That is, color was not a discrete number in the same way that it was for Nake or Struycken. At the same time, it should be obvious that these analog computers were nonetheless highly rational machines where all parameters needed to be carefully modulated and

< **3.8** John Whitney Sr., *Catalog*, 1961. 16 mm film, color, 7 min. stills. Lissajous and floral patterns curl and twist as natural, organic growth forms. Whitney produced these visual effects using a discarded antiaircraft system. Color was added after programming, using rotating colored filters. Courtesy of the Estate of John and James Whitney.

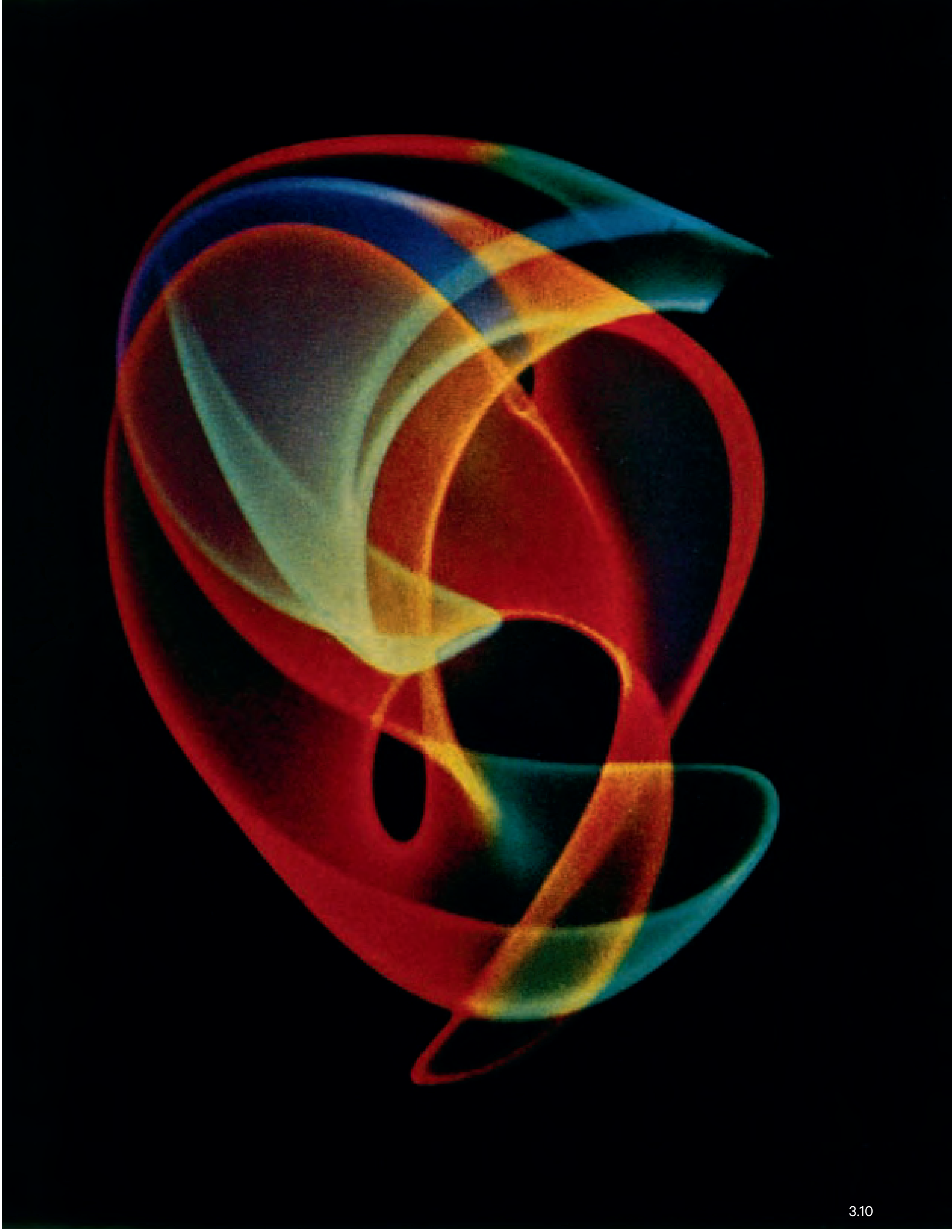
3.9 John Whitney Sr., working at IBM, 1966. Courtesy of the Estate of John and James Whitney.

controlled in advance. Finally, even after Whitney began using digital processes to generate time-based visual graphics in the 1970s, as with *Arabesque* in 1975, his thematic focus remained cosmic and mystical, and perhaps it even became more so. His primary interlocutors and influences were always people like John Cage, Wassily Kandinsky, Jackson Pollock, Arnold Schoenberg, and the artists of the New York avant-garde. In other words, his allegiance was always with the *poiesis* of art, music, and the avant-garde, not computer science or rational aesthetics.[93]

Ben Laposky and Mary Ellen Bute

Ben F. Laposky, a pioneering computer artist and mathematician from Iowa, turned to color in 1956. Laposky is now known in the history of new media for producing some of the first stunningly beautiful graphic images on the face of a cathode ray tube (CRT) oscilloscope in the 1950s and early 1960s. The CRT oscilloscope (also used in Ivan Sutherland's Sketchpad, discussed in the next chapter) was first demonstrated by Karl Ferdinand Braun in 1897. CRT oscilloscopes, as noted in the previous chapter, are like CRT radar screens, they use phosphors that are shot out of an electron gun at a high speed but once they reach the surface of the screen, they keep their glow for a significant amount of time. But unlike CRT television sets or the more recent LCD and plasma screens, which modulate luminosity and chrominance signals based on a graph-like "raster" grid or Cartesian matrix, the intensity of light in an oscilloscope is arbitrary, that is, it is steered by incoming signals in conjunction with magnetic plates inside the electron gun.[94] In other words, the vector-based oscilloscope allows one to observe the constantly varying signals and voltages in an electronic current, whether in terms of sound or light. However, Laposky, like Whitney, did not generate color using this machine. Instead he used coloring methods developed in older media, like photography and experimental film. Laposky prepared the monochrome oscilloscopes to modify, combine, and modulate analog electronic waveforms and then placed rotating colored filters in front of the display screen so that colors could be added to the images before they were seen. In other words, *after* the phosphors were shot out of the electron gun, color was added as an accessory or supplement. He then photographed the colored analog wave patterns that appeared on the screen of the oscilloscope and called them "oscillons" (figure 3.10). Laposky described his oscillons as a kind of "visual music," alluding to the work of pioneering electronic image maker, Mary Ellen Bute.

Texas-born Bute is an underrecognized pioneer of the analog electronic image. Bute studied lighting and worked with Russian Léon Theremin, inventor of the musical instrument the theremin, and Thomas Wilfred on his Clavilux color organ, during which time she developed an interest connecting light to



3.10 Ben Laposky, *Oscillon 1206*, 1960. Laposky is renowned for producing pioneering graphic images on the face of an oscilloscope. Color is added after electronic signal processing. Courtesy of The Sanford Museum and Planetarium, Cherokee, Iowa, USA.

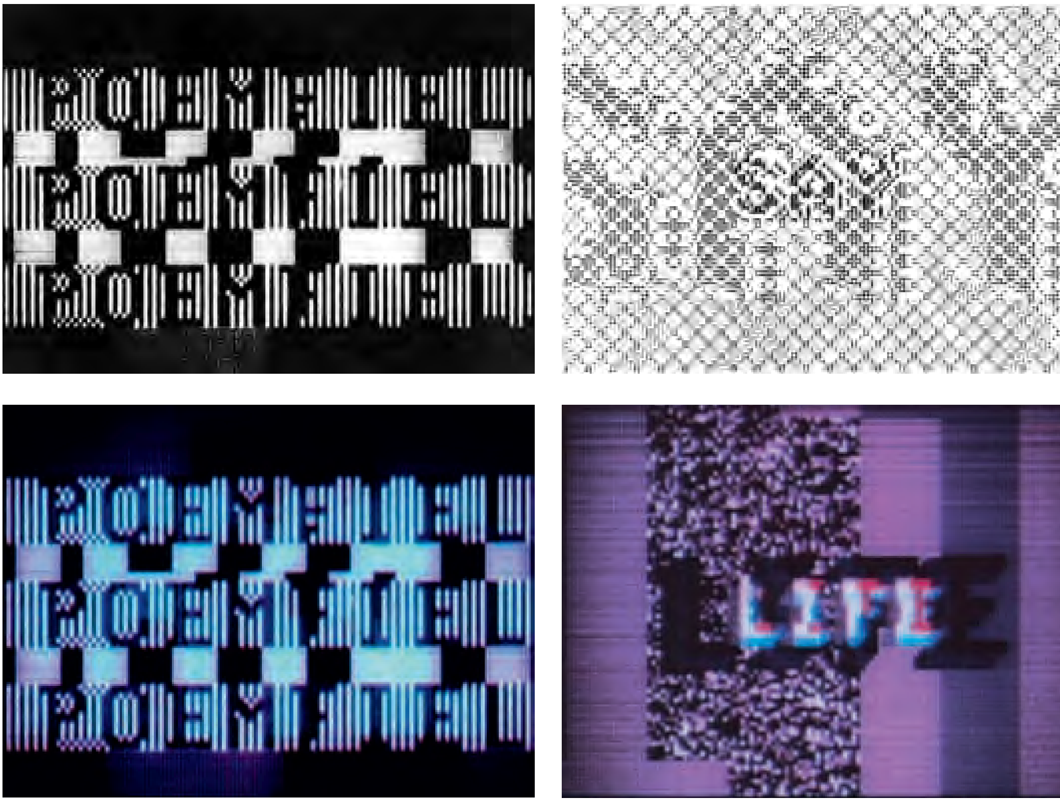
sound. In 1936 she began making her own abstract films, the first of which was *Rhythm Is Light*. With the help of Dr. Ralph Plotter of Bell Laboratories, in 1954 she began experimenting with an oscilloscope built for her as a "controlled light source" and "drawing instrument."[95] By means of buttons and switches, she was able to able to draw using the oscilloscope's rays of light like a paintbrush. Like Laposky, Bute used a film camera to record curves and lines off of the screen.[96]

Bute's contributions derive from the way in which she synchronized image and sound into what she termed visual music in 1936.[97] Her writing on the subject has been influential to artists and practitioners like Laposky, as well as experimental artists in the 1960s and 1970s, including Nam June Paik and Woody and Steina Vasulka. Finally, while both Laposky's and Bute's oscilloscope images are visually stunning, they were, like Whitney's computer art, concerned with traditional aesthetic values of beauty and the *Gesamtkunstwerk*, which is to say, unconcerned with the thematic or stylistic trope of color as number or the rational logic of computing, whether analog or digital.[98] In short, a number of early American computer artists, as Youngblood puts it, were more "interested in addressing the computer directly through graphic images rather than . . . becoming enmeshed in a 'number game.'"[99]

Stan VanDerBeek

Another key artist from the U.S. school is the American experimental filmmaker Stan VanDerBeek, mainly associated with the midcentury cinematic avant-garde, multimedia happenings, and especially the Movie-Drome he built in upstate New York in the 1970s. But VanDerBeek also made colorful computer art films and experimental videos, such as the well-known 16 mm computer animation "Man and His World" shown at Expo 67 in Montreal. For his computer art series, *Poemfields* (1966–69) (figures 3.11 and 3.12), VanDerBeek collaborated with the talented Bell Labs computer programmer and pioneering computer artist Ken Knowlton (Knowlton's artworks and contributions to this history are discussed in chapter 4) (figure 3.13).[100] The *Poemfields* series consists of a series of short computer films, poems rather, that interweave text, sound, voiceovers, and layered computer-generated and photographic imagery. For the series Knowlton used BEFLIX, a FORTRAN-based programming language he wrote in 1963 using an IBM 7094 computer, which provided a set of macros that he then used as the base for TARPS, an innovative 2-Dimensional Alphanumeric Raster Picture System (BEFLIX is also discussed in more detail in the next chapter).[101]

Color in the *Poemfields* series was also an adjunct to the computation. Knowlton explains that he was not involved with programming the color in any of the *Poemfield* films because it was added in postproduction: the computer films were "output on Black-and-White 35 mm film by means of



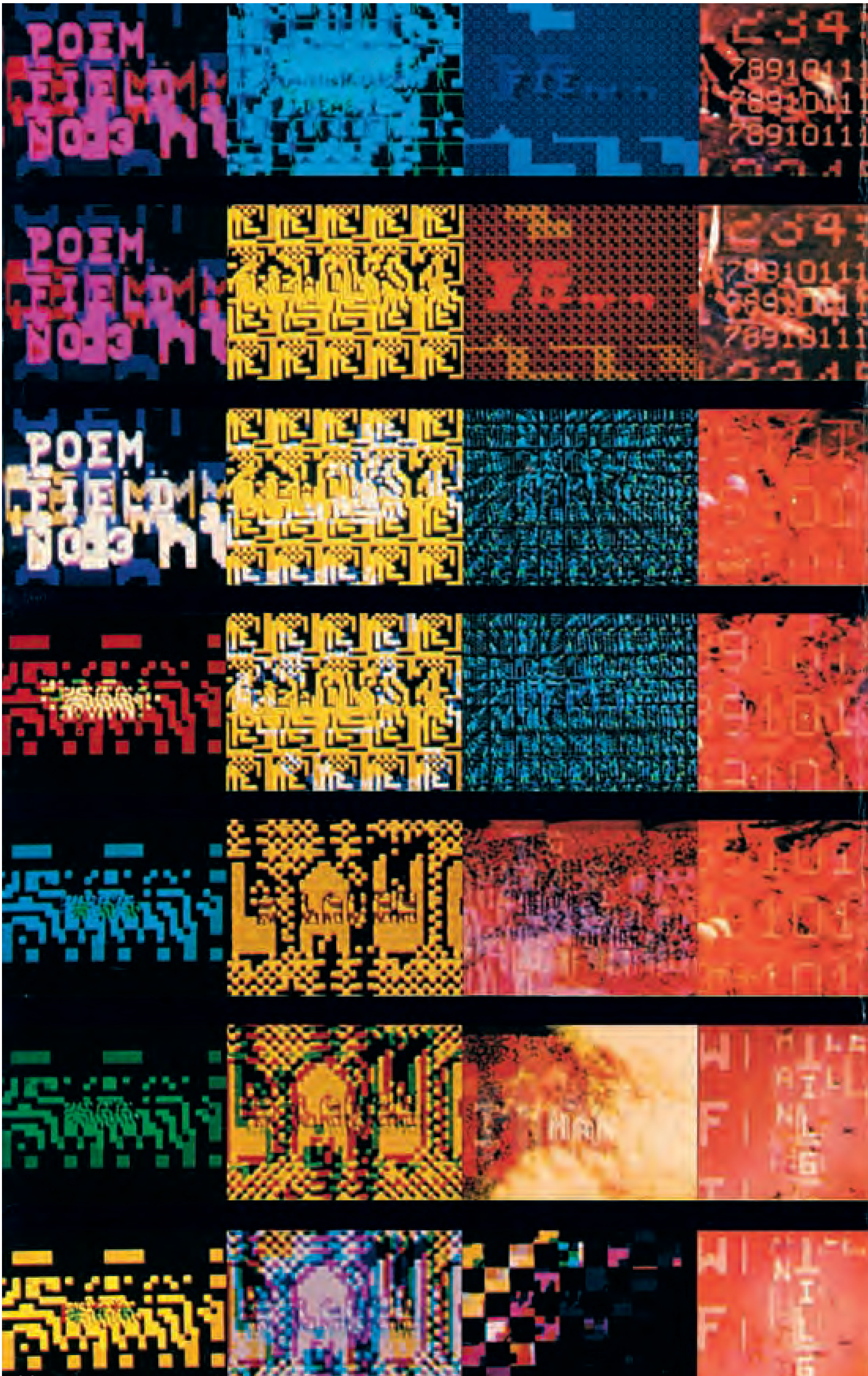
computer-written tapes . . . the coloring . . . was arranged by Stan . . . [who hired] colorists like [Robert] Brown and [Frank] Olvey."[102] (Brown and Olvey were experimental filmmakers who were known at the time for their three-strip color dye separation method, a process developed several decades earlier and used in early Technicolor processing.) In short, the color techniques used in *Poemfields* had nothing to do with rational numbers or computer programming. 3.11

VanDerBeek also made mystically colored video works using analog computers and video synthesis equipment. Three such works are *Strobe Ode* and *Color Fields Left* (both 1977) and *Newsreel of Dreams* (1976) (figure 3.14). In *Newsreel*, a lava-like Christ-figure in fiery oranges and golds appears onscreen accompanied by a solemn voiceover:

> I am the body of my mind. I am the mind of my body. I am the theater of the dream of my life. I am the dream. I am the eye of my dream. I am the dreamer in which the seams of sleep open to the stage of seeing and the audience is the insight of my dreams. . . . From the eye of dreams I see the invisible theater of reality.[103]

Such sentiments speak directly to the mystical and transcendental themes that I analyzed in the previous chapter. In the context of this chapter's discussion, they reemphasize the way in which a number of American artists appropriated

3.11 Stan VanDerBeek, *Poemfield No. 2*, 1966. 16 mm, color, sound, 5:40 minutes. In these stills ones sees the "before and after" color effects. Ken Knowlton wrote a programming language to allow alphanumeric characters to generate black-and-white images that VanDerBeek later had colorized. Courtesy of the Estate of Stan VanDerBeek.



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new computer techniques and electronic color palettes as a metaphor for the cosmic union between human and machine consciousness. The mystical eye-body sees and becomes through the new world of electric-cybernetic color. Such cosmic sentiments may seem odd to contemporary readers but they were in fact normative and characteristic of a number of artists', programmers', and engineers' approaches to color in the 1960s and 1970s. 3.13

It should also be noted that these mystical tendencies speak neither to a lack of technical aptitude nor to a lack of social and political awareness. The programming and technical challenges alone, described earlier in this chapter and in the previous chapter, attest to this. John Whitney, Ben Laposky, and Mary Ellen Bute all used highly technical processes and at times complex computer programming. My point is that at the end of the day, they looked past these technical challenges and returned color to *poiesis*; and thus, to subjective and mystical visions. In contrast, that such romantic and poetic visions of color were retrograde in rational computing was acknowledged early on in the work of Bense, Nake, and Struycken.[104] Nonetheless, the utopic and mystically colored visions of the American school must also be seen as a creative and critical device that, in its own way, *actively reconfigured and reconceptualized political and social consciousness* in the postwar era.

The reconfiguration of military weapons into new devices for social thought is precisely what Youngblood esteemed in Whitney's work when he described its capacity to transform a "complex instrument of death [into]

< **3.12** Stan VanDerBeek, *Poemfield No. 3.*, 1967. 16 mm, color, sound, 9:45 minutes. Compilation of stills. Courtesy of the Estate of Stan VanDerBeek.

3.13 (L to R) Kenneth C. Knowlton and Stan VanDerBeek at Bell Labs circa 1966–68. Courtesy of the Estate of Stan VanDerBeek.

3.14

a tool for producing benevolent and beautiful graphic designs."[105] Likewise, as avant-garde filmmaker Jonas Mekas wrote of the *Poemfield* series, "Stan VanDerBeek is one of our few genuine film artists—a poet, a clown, a laughing man of the Bomb Age."[106] In short, just because the work emphasizes colorful and utopic abstractions does not mean it is void or unaware of pressing social and political realities, and the ways in which technology was affecting and changing what it meant to be human.

Very much to the contrary, VanDerBeek was extremely aware of these issues. In 1965 he wrote:

> The technological explosion of this last half-century, and the implied future are overwhelming, man is running the machines of his own invention… while the machine that is man… runs the risk of running wild. Technological research, development, and involvement of the world community has almost completely out-distanced the emotional-sociological (socio-"logical") comprehension of this technology. The "technique-power" and "culture-over-reach" that is just beginning to explode in many parts of the earth, is happening so quickly that it has put the logical fulcrum of man's intelligence so far outside himself that he cannot judge or estimate the results of his acts before he commits them. The process of life as an experiment on earth has never been made clearer. It is this danger—that man does not have time to talk to himself—that man does not have the means to talk to other men. The world hangs by a thread of verbs and nouns. Language and cultural-semantics are as explosive as nuclear energy. It is imperative that we (the world's artists) invent a new world language.[107]

VanDerBeek's progressive ideals and ethics here, and in the *Poemfields*, are sympathetic to Heidegger's philosophy of technology. This should come as no surprise, given the widespread influence of Heidegger's thinking in Western art and philosophy. And yet in both approaches there is something *retrogressive*.

For one thing, both treat color traditionally, as a mystical and sensory phenomenon that is not in the least bit conceptualized as a material, computational, or rational phenomenon. Second, while both offer astute critiques of technology, they are somewhat nostalgic, crippled by a lingering sense of fear and loss. In this way, the abstract utopian color in the U.S. school served *both* as a critical response to and as an escape from the problems of modern technics and the emerging control society.

Neo-Romantic Backlash

While a mystical and subjective use of color was common in early U.S. computer art, it was not the *only* way computer art was approached. Counter-examples include the experimental work of American computer artist John Stehura, who programmed his computer art in FORTRAN; the work of Ohio-born Edward Zajac, who worked at Bell Labs and between 1961 and 1963 and produced the first computer-generated film to simulate a satellite in orbit; Pennsylvania-born Roman Verostko, noted above; or conversely: German pioneer Anton Zöttl, whose *Colour Composition* (1972) consisted of colorful and lyrical computer-generated drawings programmed in FORTRAN. My point here, while a general one, has been to mark an overall tendency and use of color in computer art among a number of experimental American and German computer artists in the 1950s through the mid-1970s.

In broad terms, the American school sought humanistic visions and desires *through* color in early computing, using traditional coloring methods and conservative aesthetic values, while the German approach to color was

3.14 Stan VanDerBeek. *Newsreel of Dreams: Part 1* (1976). Production view at WNET Studio, New York. Courtesy of the Estate of Stan VanDerBeek.

concerned with its rational and machinic dimensions, as well as the ways in which this rational approach was rooted in political and aesthetic ideology, which they also sought to critique. While Nake and Struycken added color in postproduction, using pens and paint, color existed for them as a numeric value from the start. Further, because color was programmed as a numeric placeholder that could be used to control any potential variable, *color as such was not specific to sensory or optical phenomenon.* Color became algorithmic. At the same time, the rational approach to color in early computing that characterizes the German school was not without its own shortcomings. For instance, the Weber-Fechner law, which allows for a one-to-one logarithmic relationship between a stimulus and a sensation, meant that art was not only measured quantitatively, but also *in advance of the actual artwork's existence!* (Though one could also argue this must be seen as part and parcel of their critique.) In sum, where the American social consciousness maintained distance from the rational tendencies in computer art, it also brought Romantic ideas about color into the rational world of computing—precisely the values the Germans sought to undermine. These two schools can therefore be seen as historical and aesthetic counterparts that inversely reflect each other's strengths and shortcomings.

The project for the Programming of the Beautiful—the rationalization of art and the role of the artist that Bense provocatively articulated—has been denied the critical attention it merits. This is because art and aesthetic criticism, at least in the U.S., have vested interests in maintaining Romantic notions of the subject and in the authority of art making. However, the solution is not simply to embrace "data visualization" trends as the new automated intelligence of the humanities. Such straightforward translations of preselected and prefiltered data do little to grapple with the underlying issues at the heart of media aesthetics. As I move into the following chapters, Bense's and Franke's rational and "objective" approach to computer art should be kept in mind as precursors to the contemporary digital colorism analyzed in part 3, characterized by a pseudo-objectivity and explicitly nonexpressionistic aesthetic. In the next chapter I continue this historical and aesthetic analysis as I move deeper into the heart of color experimentation in early digital computing in the 1960s and 1970s at Bell Telephone Laboratories in New Jersey and briefly at California's Xerox PARC.

Chapter Four
Collaborative Computer Art and Experimental Color Systems

As a research engineer who dabbled in computer-generated movies and choreography, I've come to the conclusion that most computer art done by engineers and scientists, my own work included, would benefit from the artist's touch. But the artist seeking to use the computer as a creative tool has just the opposite problem—he not only lacks a knowledge of computer technology, he doesn't even have access to a computer!

—A. Michael Noll, 1970

Most computer users take real-time interactive data manipulation for granted. Why wouldn't we? Quick and easy computing is not only ubiquitous in contemporary culture, it is increasingly mandated in work, school, and social activities. The presence of user-friendly digital color readily available in software interfaces—I will call this democratic color—makes it difficult to imagine a time when, in order to use color in computing, one needed pencils, graph paper, and likely a Ph.D. in mathematics, computer science, or engineering, as illustrated in the last chapter.

Such conditions only began to change in the years after American computer scientist Ivan Sutherland introduced Sketchpad, the first graphical user interface (GUI), or human-machine interface, for direct digital computing, developed with the TX-2, one of the first computers with a visual display.[1] Sutherland developed the system at MIT's Lincoln Laboratory for his 1963 doctoral dissertation in electrical engineering and computer science. At the time the system filled an entire room and had "about a twentieth [of] the power of a Macintosh II."[2] It was vector-based, or "calligraphic," meaning that it was based on lines, as opposed to "raster" or "bitmap" digital images, which consist of pixels.[3] With vector systems like Sketchpad, images are drawn through line-constrained shapes. Using Sketchpad's flashlight-shaped pen, one could draw directly on the screen to create and adjust line-based shapes like circles or squares in elastic band style (from the center point outwards).[4] While Sketchpad was not designed for mass distribution, it nonetheless marked a turning point in the history of digital media; the beginning of the transformation of the computer from a number-crunching statistics machine into an early illustration and graphic art system.

Sketchpad was in many ways far ahead of its time, serving as a direct precursor to almost all subsequent GUIs, including the pioneering 1979 Asteroids video game, the 1968 British Reaction Handler, and AMBIT/G (1964–68).[5] Reaction Handler, built by William Newman at the Imperial College in London (1966–67), also allowed users to directly manipulate graphics. It even introduced "light handles," an early form of what we now call "widgets." The AMBIT/G system was implemented at MIT's Lincoln Labs in 1968 and it consisted of interactive features, icons, gesture recognition, dynamic menus, selection options through pointing, and a mode of freestyle interaction. To a large degree, the future of the GUI, object-oriented programming, and the sophisticated color systems and automated paint programs ubiquitous today find their conceptual and technological blueprint in these pioneering developments.

Early Collaborations

As noted, in order to use computers to create visual art *before* automated software and the user-friendly GUI, artists needed to be resourceful to gain access to a research facility that housed a computer, or to a scientist or

researcher who was employed at one. Consider how this step alone highlights the dramatically different circumstances and challenges faced in early computing, let alone the programming and computer procedures one needed to learn once they arrived at these labs and facilities.[6]

Where the previous chapter analyzed distinctions between the early U.S. and German approaches to computer art, this chapter sheds further light on the innovations and difficulties in producing computer art and experimental color exclusively in the U.S. context. In particular, I focus on the creative and collaborative work computer scientists, artists, and engineers produced at Bell Telephone Laboratories between 1965 and 1984, including the work of A. Michael Noll, Kenneth Knowlton, Leon Harmon, Béla Julesz, Max Mathews, Joan Miller, Laurie Spiegel, and Lillian Schwartz. I also focus on Richard Shoup's benchmark SuperPaint, developed at Xerox PARC in 1972–73. The chapter's history of experimental color and computer art complements and builds on the book's broader material-aesthetic analysis of color in new media art after 1960. Before launching into this history, I first explain my satirical use of the term "democratic."

Democratic Color

In the spirit of critique, I intentionally misappropriate the term "democratic" to call attention to the overwhelming optimism and naïve attitudes saturating popular discourses about "democratic" new media. The term "democratic" implies a shared sense of power and control over a body or entity, such as the right to vote or, here, access to standardized digital color, a democratization process that began in the 1980s, when digital color was standardized in personal computing, and in the 1990s, in Internet protocols. Since then, digital color has been widely accessible, easy to use, affordable, and automated. In short, digital color has become democratic. This democratization of color has "empowered" millions of users and creative industries, bringing about benefits like increased flexibility, cross-platform working methods, communication in a common visual language, and more color for multiple forms of creative expression. In other words, the fact that digital color is standardized is in itself no cause for alarm. Quite frankly one should expect nothing less from color in a new medium. Standardization is meant to reduce the space of possibilities to a manageable subset of stable categories. Color should be useful, manageable, and functional in media technologies, ensuring artists, designers, illustrators, programmers, filmmakers, and media producers consistency in use. However, these new "freedoms" and affordances remain within the opaque and inscrutable parameters of increasingly complex systems—ones that appear transparent but are, to the contrary, highly codified, compressed, extend far beyond the literal technology, and are obfuscated from end users.

HTML color is an example of this. In order to use color on the Internet one *must* adopt the standardized hexadecimal system of color values. This system involves designating a six-digit code combined of letters and numbers, such as #3300CC for a deep blue, which is then interpreted by HTML for online visualization. HTML (Hypertext Markup Language) is a programming language conventionally used for coding and structuring the elements on a web page. Because information travels faster and more efficiently when there is less of it, HTML colors are usually reduced to a "web safe" palette of 216, regardless of how many colors an image or operating system may be able to display. But who, when, or why *these* colors are the colors offered, let alone how they are generated, remains unknown to many users (figure 4.1). This strange disparity between what appears on a "transparent" interface and its actual, exceedingly narrow and complex codification system has resulted in an unconscious yet deeply homogenized use of digital color in art, media, and design.

4.1

While I offer no pretense to expert knowledge in the engineering standards behind digital color, I do chart the *results* of these shifts through emergent ontologies and art and design practices: as democratic color here; as the "2.0 look" and Paper Rad's dirt style in chapter 5; as low-res cool green night vision in chapter 6; as the Photoshop cinema in chapter 7; and as the New Dark Age in the postscript. The issue then is not *that* this disciplining occurs

4.1 Color code chart giving the 216 standard hexadecimal values one needs to program color for the web.

but rather *how* it occurs in relation to regulating creative production, psychic experience, and the aesthetic values that emerge therein. For instance, how does a palette with many “choices” for clicking and choosing consistently yield the same results, therein altering our relationship to the computer as a creative or expressive medium? And moreover, how does the answer to this question transform throughout the history of computer art, from the 1960s through the present? After laying the groundwork for a response in this chapter, we will then be ready to address the reconfiguration of this aesthetic in the new paradigm of digital colorism in chapters 5 through 7.

An Interlude with Salvador Dalí

One day in 1970, American graphic artist, sculptor, and painter Lillian Schwartz (born in 1927) answered the telephone in her New Jersey home.[7] The man on the other end mysteriously identified himself as “Salvador Dalí’s Major.” A prank call she assumed. And yet the voice on the other end told her to be at the St. Regis Hotel in Manhattan at 7:30 that evening and to “dress in your most beautiful gown.”[8]

The Major found Schwartz in the lobby fifteen minutes early, accompanied by her son and a disguised German TV crew prepared to audiotape the exchange. She wore her “colored striped knitted gown” and “long pink and purple Mylar earrings.” The Major (Dalí’s business man) was wearing a full military outfit because Dalí felt safer around the military. He escorted them into a darkened hall where Dalí was seated on a throne wearing “black tails, a silk top-hat, and black cape lined with white satin.” He was surrounded by blonds in equally spectacular flowing white crepe dresses. When Schwartz came in, Dalí stood up, “adjusted his cape, twirled his moustache” and walked towards her “with his cane pointing straight in front of him.” He motioned for her entourage to sit down behind her and then signaled for her to sit in a chair closer to his throne. He marched over to the table beside her chair where a man appeared with three white boxes. He talked rapidly in French and Spanish and the man interpreted: “Dalí said he had received messages through his moustache, his antennae, that you and he would work together on four projects.”[9]

Only one of these projects panned out, the subject of the first white box. Dalí pushed this now open box towards her with his cane. He talked again in two languages. The interpreter explained, “Dalí wants you to examine the pen in the box, you may pick up the pen, but you must keep the cotton under it and not touch the pen.” Dalí’s voice became louder and faster. The little man continued to decode, “Turn the pen in different directions. Dalí wants you to see the wonderful sparks, the gleaming, and the rays of light shooting off and out of the pen. He wants you to videotape this pen. He knows the results will be spectacular, magnificent bursts of light.”[10]

Schwartz suggested that the particular candle lighting in the room was responsible for the gleam off the surface of the pen. This comment triggered Dalí into volatile tirade of "Spanish, French, and some English." But then he suddenly changed tones. The translator imparted, "Dalí wants you to know that he urinated on this pen every morning for one year. The encrustation, the crystals on the pen catch the light like diamonds. He wants you to record this pen, to make a tape that will catch the brilliance of this phenomenon and give it permanence. Dalí's creation will be a great visual experience. It is your job to make a permanent record."[11]

Also that night, Dalí took Schwartz upstairs to show her his "jewels," a collection of live miniature beetles and insects crawling on stones. When she realized that these little black dots were alive, she recalls feeling an "eerie sensation that my hand was cut open and ants were crawling out, just as in Dalí's painting." Dalí wanted Schwartz to create many extraordinary projects for him. However, for various reasons she denied the requests for the projects, save for the video of the urinated pen, which, she reports, turned out better than she expected.[12]

But what was it about this relatively unknown artist that caught and sustained Dalí's attention? Dalí's work was from another era in art history: modernism and its grand epoch of the genius artist, now threatened by the advent of automated computer art. In contrast, Schwartz' work, like that of others at the time, was focused on the future. The new art spoke to unknown alliances between humans and electronic machines. Many could not yet understand how or what the new breed of computer artists were creating, yet they at least recognized that there was something powerful and visionary in their work. One such person included Bell Lab's engineer Leon Harmon.

The Machine as Seen at the End of the Mechanical Age

Leon Harmon met Lillian Schwartz at the opening of Pontus Hultén's 1968 landmark *The Machine as Seen at the End of the Mechanical Age*, an exhibition supported in part by Experiments in Art and Technology (EAT) and held at the New York Museum of Modern Art from November 25, 1968, through February 9, 1969 (figure 4.2).[13]

On display at the opening night of the MoMA exhibition was Leon Harmon and Kenneth C. Knowlton's important entry, *Studies in Perception No. 1* (1966), dubbed the "Nude": a 5-by-12-foot computer-generated nude created in one of the first computer graphic languages made for raster film, BEFLIX (from "Bell Flicks"). BEFLIX was the first specialized computer animation language written to produce mosaic compositions. It could be used for pixel animation and bitmap sequences.[14] Knowlton wrote BEFLIX in 1963 using a high-level set of macro-instructions or MACRO-FAP. FAP was the machine language native

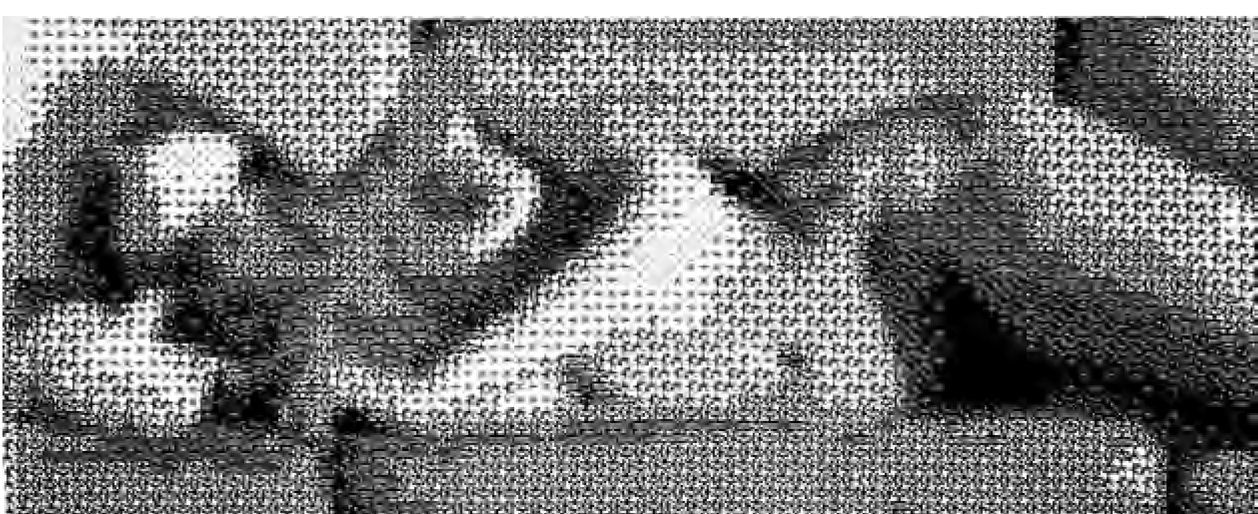
4.2 to the IBM 7094 machine that they were using at the time, and MACRO-FAP indicated an additional ability to, as Knowlton puts it, "accept a definition of a common sequence of operations, such that, for example, you could write min(a,b,c) to establish the value of the smallest of three numbers instead of writing each time the required sequence of half a dozen FAP instructions."[15] BEFLIX was capable of drawing straight lines from dots, drawing curves,

copying regions, moving regions, doing a solid fill in specific areas, zooming in specific areas, and doing dissolves and image transitions. After writing the programming language and using it to compose *Studies in Perception No. 1*, Knowlton output the piece in eight sections, using a Stromberg-Carlson 4020 printer. At the time, each minute of output cost approximately $500.[16]

The final *Studies in Perception No. 1* image consisted of many tiny electronic symbols including multiplication and division signs, transistors, zener diodes, vacuum tubes, resistors, tape reels, and writing crossovers used to compose 11 × 11 arrays. The genius of the piece was the visual effect it created where, when viewed close up, it consisted of thousands of these tiny black-and-white symbols, but when viewed from a distance, another picture came into view: a twelve-foot female nude (figure 4.3). Programming was complex and involved many tedious hours plotting numbers on graph paper, transferring them to punch cards, taking the punch cards down to the processor room, waiting in line, feeding the cards through the processor, and finally returning the next day or later to see what you got, a cycle often referred to as "blind programming," wherein one didn't see what one had until the end of cycle, at which point one usually saw errors and had to repeat the entire process.

At the MoMA exhibition, Harmon was intrigued by Schwartz's entry, *Proxima Centauri* (1968),[17] engineered by Dutch-born Per Biorn. Biorn began working with artists during EAT's infamous *Nine Evenings*, held at the armory in 1966 (noted in chapter 6).[18] *Proxima*, unlike the nude, was a mechanical and kinetic light-based sculpture, perched on a 55" × 30" × 30" black plastic base with a white translucent dome on top. The guts consisted of an old Singer sewing machine and proximity detector pads, arranged so that when it was approached by a viewer, four switches turned on a motor that lowered the dome as it changed color from blue to red. There was a projector located inside the

4.3



< **4.2** Metal catalog cover from Pontus Hultén's *The Machine as Seen at the End of the Mechanical Age*. The landmark 1968 exhibition was supported in part by Experiments in Art and Technology (EAT) and held at New York's Museum of Modern Art from November 25, 1968, through February 9, 1969.

4.3 Leon Harmon and Kenneth C. Knowlton, *Studies in Perception No. 1*, 1967. Also dubbed "The Nude." This image was featured in the Museum of Modern Art's Machine Show. Courtesy of Kenneth Knowlton.

black box that automatically alternated among eighty-one abstract slides projected onto a mirror that reflected the image onto the interior surface of the frosted dome, also mediated through a water-filled ripple tank. The tank was agitated for five seconds every minute, allowing the image to appear to settle before moving to the next one.[19] Despite the complex mechanical setup, from the viewer's perspective the piece appears simple and elegant. When reassembling *Proxima* during my archival research, I found it remarkable that the complex setup had been entirely concealed behind a plain black façade and white dome.[20] Its hidden technical sophistication enhanced the careful game of hide-and-seek that it played with visitors: as one approached the dome, it turned from a luminous blue into an alarmed red and began to sink back down into a hidden position in its base, remerging as a calm blue only when the viewer walked away.

The two pieces in the MoMA exhibition—Harmon's and Knowlton's black-and-white computer-generated nude on the one hand and *Proxima* on the other—could not have been more different. The former, while it was created using complicated mathematics and was a pioneering project in digital art, nonetheless consisted of static, geometric, and monochrome characters printed on flat white paper. In contrast, *Proxima* was a mechanical and kinetic sculpture, ushering out the "end of the mechanical age" in luminous color. Where the former was technically progressive and computationally innovative, the latter was in tune with avant-garde techniques for color in multisensory media. On this evening of mutual fascination and intrigue, the two worlds came together. That night Leon Harmon invited Lillian Schwartz to visit New Jersey's Bell Laboratories the following Thursday, where she remained for several years, working on computer art and color experiments in digital computing.[21]

Bell Telephone Laboratories

Since 1899, AT&T (formerly Bell Telephone Laboratories) had been a shareholder-owned public utility service. AT&T had made an agreement with the U.S. government to connect independent telephone companies to its network while they refrained from competitive or commercial endeavors. However, in 1949 an antitrust suit was filed against AT&T. This led to a 1956 consent decree between AT&T and the Department of Justice whereby AT&T agreed more explicitly to "restrict its activities to the regulated business of the national telephone system and government work."[21] While this decree stipulated that AT&T, then still referred to as Bell Telephone Laboratories, limit its research to telephone communications, the company was ultimately shielded from market pressures that, on the level of research, amounted to unprecedented freedom. In the words of Mervin Kelly, one of many open-minded and innovative presidents at Bell Labs during the this era, the laboratory was "an institute of creative

technology."[22] Or in the words Max Mathews, director of Bell Labs' Acoustical and Behavioral Research Center, "We had a freedom that few places had. Unlike at universities, where everyone seems to be competing with each other for scarce resources, we could cooperate. It made it a very pleasant place to work as well as richly productive."[24]

This period of freedom, which computer scientist and artist A. Michael Noll refers to as the "golden era," ended in 1984, when a second antitrust suit was settled wherein AT&T agreed to give up its monopoly on the telephone systems and compete in the marketplace with other communications companies. After this, "the Bell System was dead." AT&T and seven regional Bell operating companies (the RBOCs) replaced it. In exchange, the U.S. Department of Justice agreed to lift the constraints of the 1956 decree, thus allowing research at the labs to be conducted in areas not restricted to the telephone, such as emerging media.[25] At the same time, because AT&T now had to compete commercially, profit became a primary goal. As a result, experimental musician Laurie Spiegel, who worked at the labs in the 1960s and 1970s, explains, "a lot of pure research with questionable long-term economic benefit went by the wayside in favor of things that would bring in revenue . . . [the labs] had to sell stock and compete with each [other] in the market and fund their own research." Subsequently many of the visionary pioneers left, such as Michael Noll and Kenneth Knowlton, and new people came in who were "not the self-motivated type" as before, but who could instead "be assigned to a project that management thought was a good thing to do." After 1984, just when research into emerging media forms was legitimated, very few visionaries were left to push the envelope in new and unforeseen creative directions. Even according to AT&T, their "top 10 innovations" were made prior to 1984. Under these conditions, between 1956 and 1984, researchers at the labs enjoyed a great amount of leeway in the activities and projects they chose to pursue.[26]

Furthermore, the end of World War II brought fresh talent, new technologies, and a sense of future optimism to the United States and to Bell Labs in particular. During this time a prolific amount of innovative experimentation was conducted in a relatively open environment, laying the groundwork for "computer art" or what has become new media art, a project that began "on the side" of the official research projects. As Kenneth Knowlton describes it, "practitioners" at the labs were "tethered on long leashes if at all . . . earnestly seeking enigmatic solutions to arcane puzzles. What happened there would have baffled millions of telephone subscribers who, knowingly or not, agreeably or not, supported the quiet circus."[27]

Many of the crossovers between computing and art that began in the 1960s can be attributed to electrical engineer Billy Klüver, then working at the labs in the Communication Research Department. Klüver was also a cofounder of EAT, along with Fred Waldhauer (who was also on staff at the labs from 1956

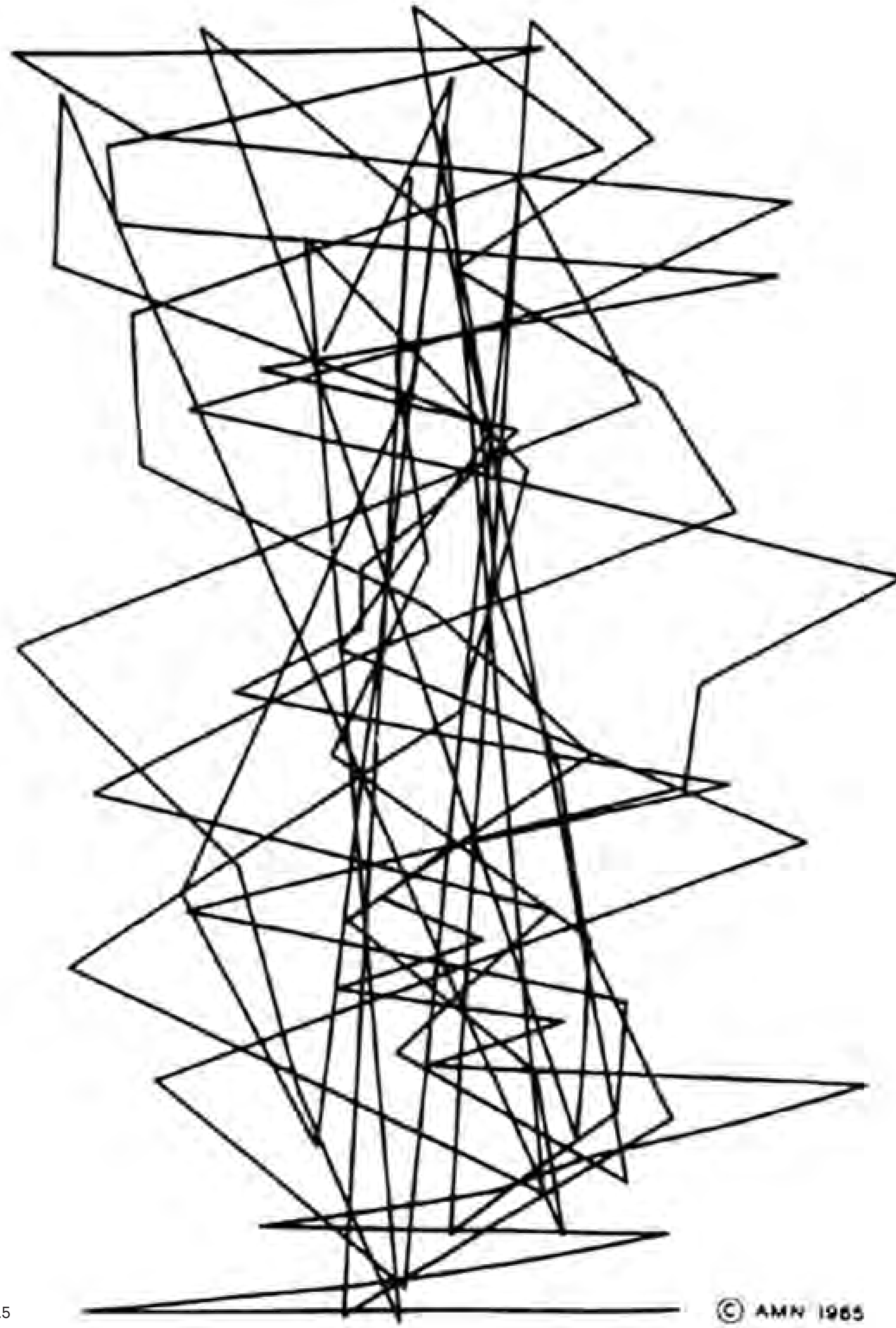
to 1987) and artists Robert Rauschenberg and Robert Whitman. For EAT's infamous *9 Evenings*: *Theatre and Engineering* performances, held at Manhattan's 69th Regiment Armory in October 1966, Klüver set up collaborations between many of the labs' engineers, including Béla Julesz, Max Mathews, John Pierce, and Manfred Schroeder, and experimentally minded artists John Cage, Merce Cunningham, Andy Warhol, Deborah Hay, and Steve Paxton. Klüver had been promoting artist-engineer collaborations by "courting downtown New York artists for some time," Fred Turner notes, and by 1966, "by his own estimate [he] had taken perhaps a hundred artists on tours of Bell Labs."[28]

Confrontations with Computer Art

As long as news of these nonofficial, on-the-side experimental and artistic pursuits did not get back to the bureaucratic sectors of the labs' management, many employees, including several prominent department heads, supported and gave significant leeway to what they perceived as good-spirited endeavors. There were, however, a few instances when this leeway was tested. In 1968, for instance, when Michael Noll was working on the picture phone (a precursor to such products as video Skype or iChat), he accepted an invitation to develop a sequence for Stanley Kubrick's landmark film, *2001: A Space Odyssey* (1968). Despite the movie's futuristic edge, when news of the scene got back to the labs, "AT&T was furious." The public relations department deeply opposed the labs being associated with commercial media (figure 4.4).[29]

Another instance occurred earlier, in 1965, when the Howard Wise Gallery asked Noll and labs scientist Béla Julesz to hang some of their experiments, some of the first computer-generated images ever produced, in its upcoming art exhibition, *Computer-Generated Pictures*. Once the labs caught wind of the event they "made an effort to halt the exhibit," but it was too late. The labs thus instructed Noll and Julesz to take out a copyright on the pictures in their own names so the "art" would not be associated with the labs. The Library of Congress, however, refused to grant them the copyright "since a machine had generated the work" and this, the Library of Congress informed them, was "not acceptable." Noll explained to the LOC that it was a human who programmed the machine. This explanation failed. In a third attempt he finally received the patent.[30] Noll is also quick to note that while the piece was not issued a copyright until 1965, it was "actually made in 1962," making it, not the computer art produced by the Germans, the first work of computer art (figure 4.5).[31] Noll's encounter with the LOC illustrates the sheer foreignness and outright rejection at the prospect of using computers to create art, as discussed in the previous chapter, a strangeness that has to a large degree been neutralized in contemporary culture (also the reason why we no longer refer to such work as "computer art," but instead as "art" or "design"). In short, it is crucial to observe how

4.4 A. Michael Noll of Bell Labs developed a sequence for this picture phone booth, featured in Stanley Kubrick's *2001: A Space Odyssey* (1968). The installation brazenly bears the Bell Labs logo.



4.5

radically different this attitude towards computer art was only a few decades ago when the term alone was met with rejection from sectors within Bell Labs, the art world, and public domain.[32]

Yet another example of these tensions between management and computer art involved Knowlton's and Harmon's above-noted *Studies in Perception* (1967), or the "Nude" (see figure 4.3). Originally made as a joke for one of their colleagues and pasted to his office wall while he was away, when the public relations department at Bell Labs caught a glimpse of the image, "[t]hey scowled and warned if you must 'circulate this thing be sure that you do NOT associate the name of Bell Labs with it.'" But shortly after the warning memo was issued, the Nude debuted at Robert Rauschenberg's loft during an EAT press conference. The next morning, it appeared on the first page of the second section of the *New York Times*, which, Knowlton notes, "made not the slightest effort to conceal its birthplace."[33] After the Nude's public debut, the labs' management sent a revised statement: "You may indeed distribute and display it, but be sure that you let people know that it was produced at Bell Telephone Laboratories, Inc." Knowlton suggests the dramatic change in attitude was due to the "venerable" status of the *New York Times*, not an acceptance of the fact that the labs' resources were being allotted to "computer art."[34] At any rate, Knowlton had by this time learned to tell people that his computer art was "made in the research lab of a large, nationwide telephone company that wishes to remain anonymous."[35]

Max Mathews and Joan Miller

As noted, the open environment during the golden era not only complemented and supported many of the research scientists' visionary and expansive practices but it also contributed to an overall sense of freedom and play. For example, grandfather of computer music and, as noted, head of the Department of Acoustic and Behavioral Research at Bell Labs, Max Mathews, used to host a string quartet in the conference room every Friday afternoon.[36] Mathews had worked in acoustic and behavioral research since the 1950s, when he analyzed the transmission of recorded speech. He soon discovered that the same principles could be applied to recorded music. By the end of the 1950s, he produced *Music 1*, written in assembler code, followed by *Music II*—the first music-synthesizing program, which not only foreshadowed today's computer music but was also an important precursor to computer graphics and digital art, in both analog and digital form. The popular interactive multimedia program MAX was one of Mathews' last contributions to the field before he passed away in April 2011. Mathews' prolific contributions to the history of electronic music deserve further analysis beyond the scope of this book.[37]

4.5 A. Michael Noll, *Gaussian Quadratic*, 1962, © 1965. This benchmark artwork was granted a copyright only after Noll convinced the Library of Congress that the image was programmed by a human and not randomly generated by "nature." Courtesy of A. Michael Noll.

By the early 1960s, labs researcher Joan E. Miller began collaborating with Mathews. Trained in mathematics at Columbia University, at the labs Miller specialized as a mathematical acoustician and conducted research in the computer simulation of the tongue in three-dimensional systems.[38] Like Mathews, she was a violinist and together they produced *Music IV* (1961–62), programmed in FORTRAN on an IBM 7094. Miller also passed away in 2011, but her experimental contributions and collaborative research at the labs, not to mention the pioneering color frame buffer she developed in 1969 (discussed below), also deserve further attention in future histories of new media and electronic music.

As the scientists and programmers at the labs were given much freedom, at least on the ground level, to explore their "on the side" creative projects throughout the 1960s and early 1970s, many of their projects involved inviting external artists and musicians to the labs, such as pioneering video artist Nam June Paik (discussed in chapter 2), experimental musician and composer Laurie Spiegel, filmmaker Stan VanDerBeek (chapter 3), avant-garde composer and music theorist James Tenney, and, as noted, artist Lillian Schwartz. The situation was in many ways analogous to the one I analyzed in chapter 2 (or to the "American school" in chapter 3) where a historical and cultural transcendence of technology occurred in a context that supported open-ended, non-instrumental experimentation.

While at Bell Laboratories, Lillian Schwartz worked with Kenneth Knowlton.[39] In the next section, I discuss two computer art pieces produced during this time: *UFOs* (1971) and *Enigma* (1972).[40] I then discuss several experimental color systems from the late 1960s and early 1970s, including Joan Miller's early three-bit vacuum tube frame buffer; Richard Shoup's SuperPaint—developed at Xerox PARC using an 8-bit color frame buffer; one color system developed by Noll, Denes, and Knowlton at Bell Labs; and two-color systems produced by Laurie Spiegel.[41]

Subjective Color in Computer Art

As already noted, Gene Youngblood's foundational text, *Expanded Cinema* (1970) defined the radical art movements and practices emerging in the 1960s and 1970s. The art he analyzed was synaesthetic, cosmic, cybernetic, colorful, ecological, synthetic, and mystical. Using the surplus of yet-to-be-fully standardized postwar technology, the then-expanding cinema sought to integrate computers and electronic circuits with human cognition and sense perception, creating cybernetic fusions to expand human experience and our understanding of the world at large. While *UFOs* and *Enigma* are not mentioned in Youngblood's otherwise comprehensive text, I show here how they nonetheless speak directly to and within this once-expanding perceptual field.

UFOs and *Enigma* accomplished several things for color in early computing: the integration of color techniques from painting and graphic design; the deployment of optical studies in perception in computer art; and an exploration of humans and machines as analogous yet distinct drawing and perceiving systems. *UFOs* (1971) begins with a quick upbeat pace. Images of solid circles and half-moon graphics flash on and off the screen in red, yellow, blue, and green, alternating among colors. Occasionally the images appear to overlap or are overlaid with other computer-generated horizontal lines. Soon enough the pace quickens to the psychedelic soundtrack created by Emmanuel Ghent and the colored shapes reach such a rapid speed that one loses track of which color one is looking at.[42] Both color and music continue to accelerate, becoming so intense that the image transforms into something else, something hypnotic and alien, but alien to what it is unclear.

While editing *UFOs* in 1971, Schwartz found an editing technique that *increased* color saturation. She found that inserting a black frame between every four colored ones helped to "keep the viewer's eyes refreshed" while the black frames remained "undetected during projection."[43] After a 1972 screening of *UFOs* at the Whitney Museum of American Art, audience members reported hallucinations and headaches and in one case "uncrossed a case of chronically crossed eyes."[44] The film, as explained in the Whitney's 1972 press release for the New American Filmmakers Series, employed the computer to create a "nearly subliminal experience of abstract reality. The stroboscopic spheres in the second half . . . have been specifically created to affect the viewer's brain rhythm and induce a mild state of alpha consciousness."[45]

The Whitney's description is significant because it points to an important and often overlooked connection between the expanded cinema and human neurology. Alpha waves are meditative and associated with idleness, relaxation, and synchronized, coherent neural activity, oscillating within a frequency range of 8–12 Hertz (cycles per second). In contrast, beta waves are associated with normal neural activity, which is also to say more active mental activity, running between 12 and 30 Hertz.[46] Television's radiant light (and by extension a computer screen) can induce a mild state of alpha consciousness, as observed in McLuhan's analysis of television as a cool medium, or in artworks like Nam June Paik's *Zen TV* (1965).[47] In other words, when McLuhan claims that television is an extension of our central nervous system, creating an auto-amputation, or "narcissistic trance," he is neurologically correct (and correct for other, material-technical reasons, delineated in chapter 2). Moreover, the fact that electronic color transmissions (regardless of content) induce a mild state of alpha consciousness further supports McLuhan's dictum that the medium *is* in fact the message, not to mention Nietzsche's claim, contra Wagner, that after 1900 aesthetics had already become nothing but "applied physiology."[48] No more disinterested judgment, reflexive intellectualism, or hermeneutics. Herein lies

the logical outcome of the theories and claims for rational aesthetics proposed in the previous chapter: if art can be calculated by a computer, then so too can its sensory and aesthetic reception.

Op Art

The similarities between *UFOs* and op art are not insignificant either, given the latter's focus on physiological control through visual stimuli. Op art emerged in the late 1950s and 1960s, alongside the advent of color television, as one of the first "popular" art genres after Pop itself. Just as television offered a lowbrow alternative to the hi-brow auteurism of the cinema, op art offered a pop alternative to the elite and ego-driven modern art movements like abstract expressionism. The movement is primarily associated with artists like Bridget Riley, Victor Vasarely, Ernst Benkert, and Victor Mosoco, and thematically its concerns lie with subjective, physiological reactions to abstract shapes and colors. In this way it is heavily indebted to the then current research in optics and studies in perception, just as the Impressionists and neo-Impressionists were indebted to nineteenth-century research in perceptual color mixing. As op artist Bridget Riley declares in the title of her 1965 *Art News* article, "Perception Is the Medium." Op art brings colors and visually difficult color combinations into explicit focus, generally through intense abstraction, in order to continually ask questions about the *fact of perception itself*: what do we see here that we fail to see while "seeing" in the world at large? Or rather, how is "normative" perception in fact blind to numerous colors and experiences?

Similarly, *UFO*s asks how normative (human) perception can be expanded to see what is also *already* in computation, but not yet visible. There is thus something both foreign and welcoming about *UFOs*. The piece is a disarming and strange assault on visual perception, an aesthetic not uncommon at the time (many similar psychedelic and stroboscopic experiments were developed throughout the United States and abroad in the 1960s and 1970s).[49] Writing about *UFOs* in 1972, Bob Lehmann observes, "It is strange to feel your body physically moving, directed only by the gravitational effect of a moving two dimensional image . . . In addition to being creative, inventive and extremely colorful, the manipulating of the mind that goes on in some of the films of Schwartz and Knowlton is interesting and even a bit frightening."[50] In 1971, critic Amos Vogel wrote that the "stroboscopic effects" in *UFOs* were "unsettling." "Even more ominously," he continues, "while [its] design and action are programmed by humans, the *result* in any particular sequence is . . . [not] entirely predictable . . . being created at a rate faster and in concatenations more complex than eye and mind can follow or initiate."[51] *UFOs*, like many op art works or expanded cinema films of the era, begins to retrain audiences for increasingly rapid and compressed perceptual experiences, ones that have

only become more abundant on the Internet and through the miniaturization of personal screen technologies, planting the seeds for "hyperdividuation," as I theorize it in the next chapter.[52]

UFOs achieved a breakthrough in editing and effects research. It not only introduced a new style and color technique that digital videos, web animations, and commercials now mimic (illustrating what Stiegler refers to as the development of attention-forms), but it also brought color into a medium that did not have it. This was done in two ways. The first was to bring color into the work using color alteration techniques common in avant-garde and experimental film practices.[53] The second was the use of optical techniques to intensify the colors through black frame inserts. The black frames, which allowed the other colors to stay crisp and fresh, functioned on the level of subjective perception, providing a temporary reprieve for the eyes. In reference to a later but very similar film, *Googolplex*, Bob Lehmann explains, "Schwartz and Knowlton have gone further in that they activate the brain to receive this black-and-white film in color and also, apparently, alert the brain to follow a mathematical progression which I interpreted to be creating a new (deciphering a lost?) language."[54] Indeed, a new "language" that learns to speak, or rather teaches us to "read," or more appropriately to "scan," the screens and interfaces of computational media. In order to fully appreciate this adaptation of optical research in computer art, I discuss the 1972 film *Enigma*.

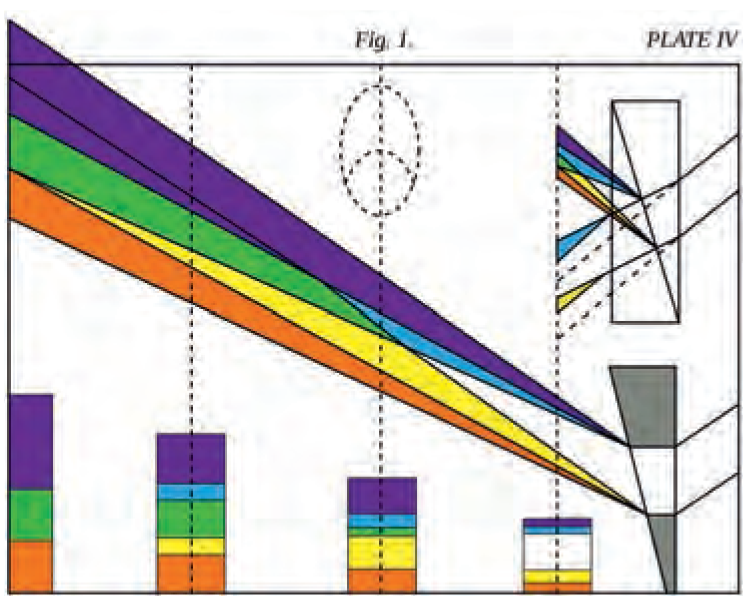
In *Enigma*, a series of black-and-white checkered, striped, and patterned squares flash on and off the screen. Eventually color appears *within* and *in between* the black-and-white images. These colors are much softer than the bold and intense hues of *UFO*s, painted in muted primary colors (reds, greens, and blues). At first the speed of the color animation seems slower than *UFO*s, but eventually the black and white stripes begin to move fast, too fast to focus on any single one.

For this piece Schwartz drew on techniques from Polaroid's cofounder Edwin H. Land,[55] then giving lectures on color perception at the labs.[56] The goal was to produce an animated digital work that integrated experimental research in optics and simulated the perceptual effects of color intensification.[57] The result was *Enigma*:

> *Enigma* created the illusion of saturated colors even though it was shot in black and white. Dark frames and texture frames were inserted in a determined order in the black and white section of *Enigma* to provoke color . . . Color replaced the black-and-white sequences in the same order as those provoked by the black-and-white sequences, resulting in the maintenance of a more saturated appearance of colors . . . If the lines moved and intersected enough, an observer would start to perceive saturated colors between the lines.[58]

While the application of this effect into computer art was new, the effect itself was not. As noted, inspiration for *Enigma* came from the research on

color perception produced by Land, who was in turn influenced by nineteenth-century physicist James Clerk Maxwell, whose childhood toy—a spinning top—produced the same phenomenon of optical color mixing. Further, Maxwell's color experiments are in fact attributed to Goethe, who, in his landmark *Theory of Colours* (1810), prioritized subjective color mixing over Newton's objective color analysis (for more on this see chapter 1). Goethe also proposed the "edge theory" of color (figure 4.6), a thesis that correctly argued that color is not *in* light, but in fact emerges *in between* black and white, a hypothesis that can also be connected to Aristotle, who argued that "all hue is to be considered as half light, since it is in every case lighter than black and darker than white."[59]



4.6

In the nineteenth century, Maxwell and his peers, including Hermann von Helmholtz and Gustav Fechner, were inspired by Goethe's work, as were the op and light artists in the twentieth century. What appealed to them in Goethe's color theory was the way in which color was seen and theorized on the *edges* of perception, making visual experience highly subjective. Subjective perception and optical color theories remained à la mode in avant-garde film and computer art throughout the 1960 and 1970s. However, as I will show in the last third of the book, in the 2000s these subjective approaches fell out of fashion.

Another technique used to generate color in *Enigma* was color intensification. As color appeared, more actual color was added, which accentuated the effects of the illusionary color.[60] In addition to building on research in optics and color perception, *Enigma*, like *UFOs*, expanded the perceptual field in early computer art. Much of this was possible because the long tradition of color

theory was brought into the new world of computer graphics.[61] Both of these computer art projects use rapid, stroboscopic computer animations to generate color in subjective perception. *Enigma* illustrates how color exists between the (objective) screen and the (subjective) human. Its blueprint was created during programming, editing, and production, but the work itself comes to life when it is being watched, expanding perception.

To approach color in this way—through its material-technical *and* subjective attributes—is to embrace the paradox of color at its root. In *Enigma*, both sacred and synthetic color form a constitutive tension that allows the work to *work*. As discussed in chapter 1, sacred color tends to bear anthropocentric associations, while synthetic color tends to denote artificial and machine-made ones. However, sacred color must not be confused with antiscientific, naïve, or romantic notions of color. Rather, as I argue throughout, sacred and synthetic color coexist, especially in this particular historical and cultural moment of technological intrigue, a fascination with the future, and progressive social and political attitudes towards human-machine consciousness. It may even be the case that it is *only* in these moments of open, visionary pursuit, prior to a color's standardization and democratization that such coexistence is possible.

Finally, much of what this work has to offer has yet to be realized (or properly documented) in media art histories. For instance, one of the Bell Labs technical reports for *Enigma* notes that it was an "[e]xperiment combining various filters to produce the spectrum of color. The sequences used to induce psychological and physical effects could eventually be part of a computer language and coded into the final programming."[62] Such a program (for better or worse) has yet to be seized for commercial or artistic endeavors.

SuperPaint and the Frame Buffer

In the 1980s and 1990s, digital color became democratic, first through hardware, second through commercial "off-the-shelf" software with color lookup tables (LUTs), and third, through the standards established in the World Wide Web Consortium (W3C). That is to say, digital color became ubiquitous, affordable, and standardized on a mass scale. Engineers and programmers developed compression codecs for digital files (such as the GIF format in 1987, JPEG in 1992, PNG in 1996, and eventually the MPEG-4 and H.264 in 2003) and web coding languages (like HTML in 1990) to support and help standardize color in digital images and web pages. There are many benefits to the democratization of color: it is flexible, available, and efficient for artistic, intellectual, and social expression, it provides a common language for communication, production, and information distribution, and it is a relatively cost-efficient means to do so. But what has been left behind and forgotten in this process? As a preliminary response before this chapter's conclusion, I want to consider,

4.6 Johann Wolfgang von Goethe, diagram from *Theory of Colours*, 1810. Goethe's edge theory illustrates how color emerges through overlaps and black-and-white edges. Courtesy of the Goethe-Museum Düsseldorf/Anton-und-Katharina-Kippenberg-Siftung, Düsseldorf, Germany.

by way of contrast, a few truly unique color systems as envisioned and brought to fruition *before* democratic color, through early frame buffer technology in the late 1960s and 1970s.

A frame buffer is a two-dimensional array for storing the color information for each frame of an image, and a color lookup table (LUT; or simply a color table) is a set of predetermined values that enable one to control and change the color of objects and areas within a single image. A color table is key for color gamut corrections, creating pseudo-color displays, and digital color animation. Richard Shoup describes the way in which a frame buffer and color table function within the computer system:

> Numbers stored in the frame buffer memory at each pixel can be thought of as representing virtual color names in a manner analogous to a virtual address space. For example, if the frame buffer stores 8 bits/pixel, then 256 independent virtual colors may appear within the picture. The color table consists of 256 words, each containing the values of the red, green, and blue components corresponding to one pixel value (color name). During scanning, each pixel value is read from memory and is used to address the color table RAM.[63]

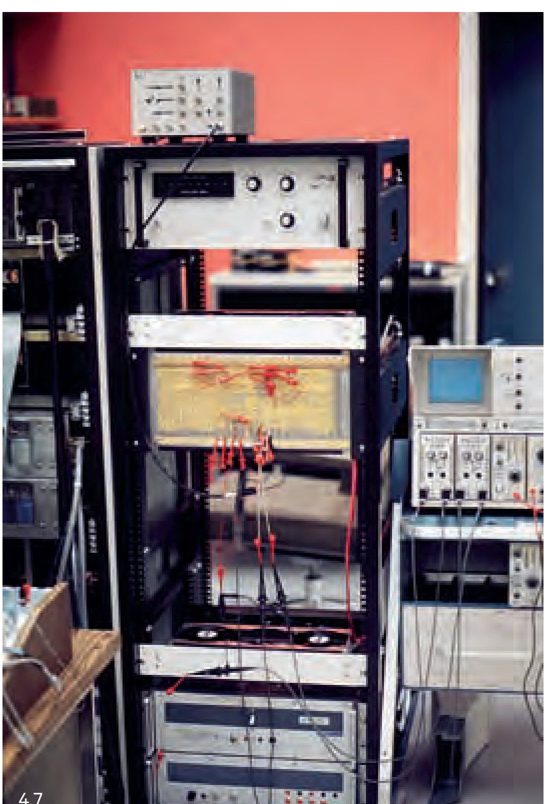
The genius of the frame buffer is that it combines computer graphics with video *and* holds color information in a two-dimensional array in computer memory *before* rendering, a technique that greatly accelerates the rate at which raster images can appear onscreen.

Frame buffers became feasible after developments in integrated circuit technology in the late 1940s and 1950s (which began to replace vacuum tubes) and their subsequent use in microprocessors, leading to the miniaturization of the computer processor into a single chip (known as the CPU) in 1971.[64] The new integrated circuit microprocessor, with 1 Kbit of RAM, replaced large and bulky vacuum tube systems. The significance of both the integrated circuit and microprocessor in the history of computing are dramatic and cannot be properly addressed here.[65] Suffice it to note that once combined with the frame buffer and color indexes (LUTs), computer graphics radically transformed in both design and functionality.

One of the first color frame buffers was a rudimentary, vacuum-tube system built by Bell Labs scientist Joan Miller. Miller's system was a primitive paint program with three bits of color depth and an early fill algorithm for the frame buffer, limited to convex shapes or shapes that had simple connections between them.[66] Her pioneering system was nothing like the complex memory systems used to store and manipulate images today. It used three frame buffers, one for each color, or, bit. A "bit" is short for binary digit, so in a one-bit system, each pixel has only one channel and is without color or grayscale variation. While Miller's system was innovative it was also extremely slow and bulky and soon fell by the wayside.[67]

While working in the Computer Science Lab at the Xerox Palo Alto Research Center (PARC) in 1972–73, Richard Shoup, in collaboration with colleagues Alvy Ray Smith (discussed in the next chapter), Bob Flegal, and Patrick Baudelaire, began to develop a more manageable digital color paint system with early frame buffer technology, called SuperPaint. Shoup developed most of the hardware and software for SuperPaint on his own while Smith, Flegal, and Baudelaire occasionally contributed input or wrote routines for it. Shoup used a Data General Nova 800 minicomputer as the system controller and wrote its programs in BCPL language, a precursor to C, and some assembly code (figure 4.7). The SuperPaint system had two multiplexers that could perform a number of tasks including accepting a monochrome analog input signal and transmitting it to a 10-bit component color lookup table on a pixel-by-pixel basis. Its hardware also consisted of sixteen printed circuit cards filled with 2-Kbit shift register chips (Intel 2401), and an 8-bit digital color system that integrated computer graphics with a video rendering display of 640 horizontal pixels by 480 vertical pixels. In other words, the system had "640 × 486 × 8 bits," which equals 307,200 bytes of memory (there are 8 bits in a byte). As an aside, there are 1024 bytes in 1 kilobyte, 1024 kilobytes in 1 megabyte, and 1024 megabytes in 1 gigabyte. Now compare this value—307,200 bytes of memory in 1972—to the standard 4 gigabytes of memory in a 2014 "off the shelf" iMac. This almost unfathomable boom in core memory attests to the unprecedented rate of development within the computer industry, due in large part to developments with the integrated circuit.

Also at this time, Ken Knowlton was building a color display system (noted below), while other frame buffers were developed elsewhere by Jim Kajiya and Ivan Sutherland for instance, most notably their "Random Access Video Frame Buffer."[68] There was also John Whitney Jr.'s and Gary Demos' 1000-line frame buffer, developed at Information International, Incorporated ("Triple I") using a PDP-10s computer and "Foonley Machine," and the California-based Ramtek Corporation's "9000 Series Display Systems."[69] In sum, in the 1970s color tables and frame buffers came to provide extremely useful and inexpensive techniques for creating real-time color animation and digital graphics.



4.7 Richard Shoup's innovative SuperPaint hardware under construction circa 1973. The system sat on two five-foot equipment racks, one for the digitizer and one for the Nova 800 controller. Courtesy of Richard Shoup.

Eventually a SuperPaint user could control and choose which tool, color, or brush he or she wanted to use with only a mouse click (figure 4.8). The system could render 256 colors selectable from 16.7 million, and had all of the basics of a modern paint program: video in and out ports, color palette, colormap, tablet and stylus, variable paintbrush size, animation, video magnification, image transformations, and image input and output. In total, the system sat on two five-foot equipment racks, one for the digitizer and one for the Nova 800 CPU, which over time accumulated new devices, controller cards, and interfaces.[70] Key here is the way in which SuperPaint adopted standard video image parameters so it could record its output signal to videotape or videodisc recorders (VCR), or transmit it to a broadcast television channel. Because the system was set up to receive input and output data, programmers could write into the frame buffer in real time or change the virtual color space in a relatively short time, such as during the television display's horizontal or vertical blanking intervals, and the changes would instantly appear on the video monitor.[71]

Many contemporary users take this kind of real-time interactive data manipulation for granted. But one must recall that in these early years, digital computer graphics systems were designed by people like Sutherland and Shoup who had to actively work against the prevailing logic that the computer

4.8

is a "general purpose" machine or nonvisual number-crunching apparatus. And thus another challenge faced in these early years was finding ways to compress enormous calculations into less time and space and still yield decent visual results. Pioneers like Sutherland, Shoup, and Knowlton changed the game, and it is not surprising that such a dramatic reconfiguration of the medium, as discussed in this and the previous two chapters, would inspire the visionary and utopic artwork that it did.

Once SuperPaint was in running condition, new people (namely artists) emerged, and new applications were established. Artist and mathematician Fritz Fisher, for instance, took a job as a "night guard" at Xerox PARC in order to "obtain access to the system." In 1974, he used the system to produce an image he called *Black Girl*. In the same year, artist and designer Bill Bowman used SuperPaint to create the first real-time animation, *SLOT animation*.[72] In the late 1970s Shoup joined forces with graphic artist and illustrator Damon Rarey at KQED to produce graphics with SuperPaint for the PBS television series, *Over Easy*. Soon afterward, in December 1978, Shoup and Rarey collaborated again at Xerox PARC on a project to use SuperPaint for NASA's Pioneer mission to Venus. SuperPaint performed well and Shoup was invited back to NASA in 1979, to play a role in visualizing the Pioneer spacecraft mission to Saturn.[73] While the details of these fascinating activities are beyond the scope of this book, it is important to at least recognize in them the precursors to digital data visualization, or "serious science illustration," as Shoup puts it.

In 1983, SuperPaint won an Emmy for Xerox. And while it is still not widely known, the device is pivotal in the history of computer graphics and digital color in particular because of the way it merged computer graphics with video and televisual media, therein allowing users to manipulate the colors directly through the Nova CPU.[74] Even though the system was influenced and inspired by several before it—including Miller's 1969 system, the Scanimate discussed in chapter 2, Thacker's Alto bitmap display (1973), the Tri-Color Cartograph analog-disk-based paint system by Kunitz and Poppelbaum at the University of Illinois (1969), CharGen Paint by Kay and Purcell (Xerox, 1972),[75] and of course Ivan Sutherland's Sketchpad—its efficiency, flexibility, and functionalism in regards to color helped pave the road to our contemporary culture of remix, hybrid media, and recombination aesthetics, which I expand on in the next chapter.[76]

Collaborative Color at Bell Labs

Numerous frame buffers and color paint systems sprang up in research labs and universities during these golden years. I here note only two more systems produced at Bell Labs in order to emphasize the truly collaborative, nonproprietary spirit that characterized the emergence of these early color systems.[77]

The first is the digital color system built between 1971 and 1972 by a number of the labs' engineers and scientists (at the time unknown to each other). Thanks to department head Peter Denes, around 1969–70 Bell got a Honeywell DDP-224, one of three such systems in the world. The Honeywell was the first online interactive system that replaced the IBM 360/50 at the labs, which ran with a 7094 emulator, an "offline" system that used magtapes for storage. The

4.8 Richard Shoup, "SuperPaint Menu," circa 1976. Shoup developed the first 8-bit digital color system with a frame buffer in the Computer Science Lab at the Xerox Palo Alto Research Center (PARC). Courtesy of Richard Shoup.

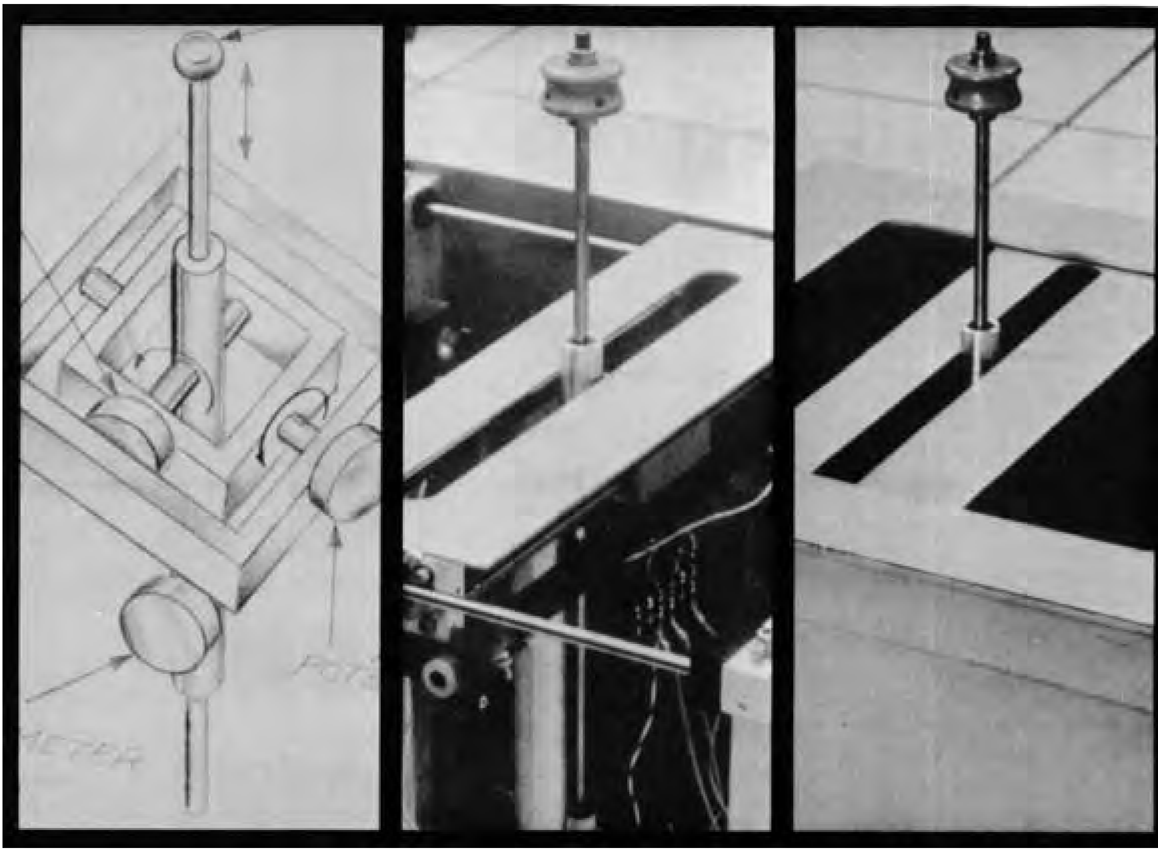
Honeywell arrived with a black-and-white frame buffer. Experimental composer and musician Laurie Spiegel, who also worked at the labs in the 1970s (and who often came in at night and on the weekends with a sleeping bag, to make the most of her time on the computers when the full-time employees were not there) explains that the DDP-224 had about "8k of core memory total, which was about the size of 4 refrigerators." It couldn't go over 58 degrees, and this was routinely monitored. Alongside the limited memory, processing was extremely slow. Core memory was so slow, Spiegel recalls, "you could take the memory card out of one computer, walk down the hall and stick it another computer, and it would still have the memory on it."[78]

Michael Noll then built on top of the black-and-white frame buffer that the Honeywell already had in place. He developed a stereoscopic 3D interactive tactile joystick (figure 4.9). The system consisted of a large box that sat on the floor with a carriage that ran across it with rollers at the left and right ends. Sticking up out of the box was a wand that could move in three dimensions, using a two-phase induction motor to "control the force between the user's hand and the device."[79] The system was an early form of "tactile virtual reality," Noll explains, "with the three-dimensional man-machine communication device, you can 'feel' a three-dimensional object which exists only in the memory of the computer." Noll programmed the system in FORTRAN to draw shapes, most commonly a sphere. However, Noll left the labs in 1971, after which the future of this device became somewhat muddled.[80]

In 1972 Peter Denes developed a computer-controlled color encoder for the Honeywell's black-and-white frame buffer. This color system was a three-bit system that could produce eight possible colors for each pixel in a frame. In order to get around the limited number of colors he also developed a seven-bit frame alteration system that gave the illusion of a much greater number of colors in the system.[81] At this point the two projects—the joystick and color frame buffer—were distinct, but they would not be for much longer.

Around this same time Lillian Schwartz, trained as an artist, wanted to use color intuitively in digital computing. "Calculating colors seemed unnecessary," she remarked.[82] In response, Kenneth Knowlton, somewhere between 1972 and 1973 (the vagueness speaks to the labs' then-lack of concern with competitive patenting), "helped to eliminate these steps"[83] by integrating Denes' color frame buffer for the Honeywell with Noll's joystick and his own EXPLOR (Explicit Patterns Local Operations and Randomness), a programming language Knowlton wrote in FORTRAN that allowed one to manipulate "rectangles and squares in two-dimensional blacks, greys, and white."[84] Using EXPLOR, Knowlton ingeniously encoded the joystick to transmit color pathways in 3D color space.[85]

His innovative color system was capable of generating eight to sixteen colors and altering their hue, saturation, and brightness levels. Second, it could



move through color space intuitively and interactively with the hand-controlled joystick. He explains, "You could move from black to green, with nothing else in between. You could also define a path in color space from which individual colors could follow, at different speeds."[86] Schwartz found the system "instantaneously gratifying."[87] With this device, "instead of thinking about color values," she writes, "I could push the joystick one way or another and have the computer do all the calculations."[88] The color joystick was used in several projects created between 1974 and 1976, such as *Pictures From a Gallery* (1974), *Metamorphosis* (1974), and *Metathesis* (1974).[89] Schwartz's sentiments are similar to those of pioneering computer artist John Whitney Sr. (see chapter 3), who, while in residence at IBM, worked under the guidance of programmer Jack Citron, about whom he writes, "The software program Dr. Citron developed for me is like a piano. I could continue to use it creatively all my life."[90] 4.9

Knowlton's color system was innovative, but the computers it ran on were slow and bulky, occupying two entire rooms. The machine with the processor resided in one room and the humans worked in the other. Luckily the two rooms were next door to each other, with a window adjoining them, through which they could see the monitor and animation camera. And even

4.9 A. Michael Noll's 3D interactive stereoscopic joystick, 1970. Courtesy of Michael Noll.

though color was now being generated through the computer, they still output to film or magnetic tape (an early form of digital recording to audio and videotape). Knowlton coordinated the animation camera with the computer to capture, he proudly recalls, at one frame per second![91]

Knowlton's development of this color interface, like Sutherland's and Shoup's, marks another important step in the move towards automated software interfaces and user-friendly digital color. Automated software conceals the complexity of computer operations and the fact that color in digital computing is *always already a number*. Moreover, in the collaborative spirit of the labs during these golden years, the color system resulted from several individuals' visions and innovations, making it a somewhat anonymous, open, and at the very least, a nonproprietary computational color system. With this joystick and color interface, color existed in a threshold position. It had been made technical and mathematical, but the encodings were specific to personal visions and desired uses. "Each imaging system developed" in this period, engineer and video artist Stephen Beck explains, "reflected the technical and artistic capabilities of its maker—in some systems the resultant image is the product of the inherent circuit design, in other systems the electronics produce a more specific visual or psychological effect." While Beck was writing with particular reference to video synthesizers, his observation is nonetheless valid here.[92] It is not coincidental that such subjective and personally designed systems are now obsolete. They are costly and time consuming, and the majority of (industry) concerns with digital color today lie exclusively with proprietary algorithms that deliver highly compressed semblances of the analog world.

VAMPIRE

My final example in this chapter is the color system developed by experimental musician Laurie Spiegel at Bell Laboratories in the 1970s (figure 4.10). In 1974–76, using a Rand tablet (an early device for freehand drawing) and FORTRAN IV software that she wrote, Spiegel developed an early raster-based color drawing (or "paint") program that could produce static color images computationally.[93] The look and feel of these images have qualities of both digital computation and the shifting colors of analog video, a quality that allows them to partially escape the chunky pixelated aesthetic otherwise pervasive in early computer art. Her images involved an innovative production process. She "created the images by drawing on the Rand tablet with one hand while manipulating knobs and switches that controlled color, line, width, texture, etc. with the other hand." In contrast to Knowlton's method of "computing each image using logical processes," or process-oriented languages like EXPLOR, Spiegel created the images by "drawing directly

4.10

[on]to a luminescent display screen" with the Rand tablet and then capturing them by taking a photograph with her own camera (figures 4.11 and 4.12).[94] The program Spiegel used to create these images later became a component of her VAMPIRE (Video and Music Program for Interactive Realtime Experimentation / Exploration), given this acronym because it "could only be used at night."[95]

VAMPIRE was an interactive color-music system that in some ways trumps the efficiency of Knowlton's pseudo–real time color joystick. To start, Spiegel built on top of Max Mathew's GROOVE system. GROOVE (Generated Real-time Output Operations on Voltage-controlled Equipment) was a hybrid music-image system, also developed on the Honeywell, which gave composers the ability to manipulate sound in real time with corresponding changes reflected in a cathode ray tube display. GROOVE produced sound through an interface for analog devices with two twelve-bit digital-to-analog converters. Its input devices consisted of a twenty-four-note keyboard, four rotary knobs, and a rotary joystick.[96] With this base, she used the Rand tablet and one routine she received from Knowlton to access the frame buffer. She used the same frame buffer that Knowlton and Schwartz were using, but "instead of routing that to a [film] camera I added video sync data electronically and routed the signal to a video recorder." The result was a

> control system to create abstract (electronic) patterns of change over time. It was meant to . . . control audio equipment but I used it for visuals too. [The system] controlled color parameters in the same way the system normally controlled aspects of sound. The reason I could attain real time speed

4.10 Laurie Spiegel at the computer at Bell Labs. Photograph by Emmanuel Ghent © 1978. Courtesy of Laurie Spiegel.

was that unlike Ken and Lillian I used video (electronic) instead of film (chemical) recording.[97]

VAMPIRE could record live interactions and store changes that occurred in the system over time. It could also incorporate generative (algorithmic) processes for both image and sound.[98] Some of the experimental visual effects it could produce have since become common, if not banal (for instance, the animations that synchronize abstract color with sound and can be downloaded from many Internet radio stations).[99] However, as is the case with much of the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computer art made at Bell Labs in this period, no artifacts or images from VAMPIRE remain. Many of these systems were never formalized or patented, and thus many of the sophisticated and innovative processes involved, and in some cases the work itself, have been lost. Finally, the fact that electronic color has been almost ignored in new media art histories has not helped to enhance or preserve these developments.

1984: Democratic Color

By the late 1970s and early 1980s, political conservatism and corporate ambitions infiltrated the labs, bringing an end to the golden era of liberal experimentation that took place in the 1960s and early 1970s. In 1981 Knowlton wanted to patent a new technology that was a direct precursor to today's text messaging systems, but the labs' (now AT&T's) public relations department answered "no." They did not want him "to talk or lecture about it anymore." At that point it was clear to him that things had dramatically changed and, being one of the last creative experimental technologists remaining, in 1982 Knowlton subsequently took a job at the Stanford Research Institute (SRI International).[100]

Bell Labs' initial denial of this early experimental work in an area that today is central not only to "telephone" communication technologies but to almost all digital media, reflects the labs' status as a once-shielded monopoly, a status that ended with the deregulation in the 1980s.[101] While this status temporarily protected the researchers from market pressures, it may have also cost the labs an innovative edge in the new media industries and international notoriety. Three interrelated factors explain how this happened. Prior to 1984, even if Bell Labs saw a future in computer art, the pressure of the government's 1956 decree that restricted them to carrying out only those research projects related to the telephone meant that it was unfeasible to pursue patents on these developments. (So even if this kind work was being conducted at the labs, which it was, it was best not to publicly announce this to taxpayers.) Second, even when lab engineers wanted to claim authorship, if a project was too "artsy" or too far beyond what could be defined as "telephone communication," it was hindered, and increasingly so by the late 1960s and 1970s. And third, because these artworks were a product of collaborations that were often unknown or anonymous, even if the engineers or artists had wanted substantial recognition, pursuing it would have been precarious. Finally, these extensive collaborations spanned several undocumented years and often involved participants who left little to no trace or record of their work.

Moreover, Bell Labs was one of several U.S. research centers that, like Xerox PARC and IBM, have since been overrun by market influence and changing political and economic tides, including the ubiquity of the personal computer and the rise of digital media centers and computer art programs in the

4.11–4.12 Laurie Spiegel, "Xerograph Images," 1974–76. Images from an early computer drawing ("paint") program Spiegel developed at Bell Labs using a Rand tablet and FORTRAN IV software. One component of this system modeled as a blueprint for VAMPIRE. Courtesy of Laurie Spiegel.

1980s. The standardization and automation of what I call democratic color also soon took root on the Internet and in commercial and industrial software applications, from high-end Avid video editing systems, to Flash for web design, to generic Microsoft Word applications.

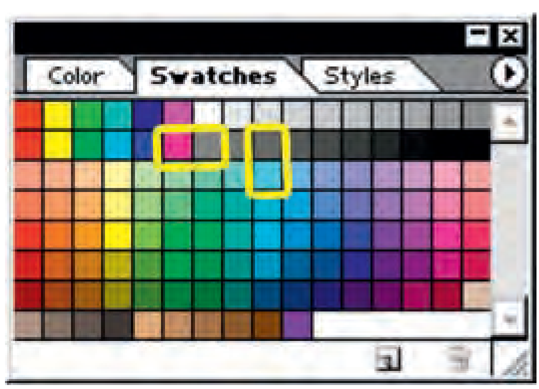
The democratization of color, as noted, is my own doublespeak. Democratic digital color is bright, fun, easy to use, has widespread availability and access, but it is also bound up in a radical homogeneity of use and enforced protocols and compression standards, which in turn, contribute to a greater opacity and inaccessibility to basic color-computational processes. If one wants to use digital color today, one *must* use certain automated palettes and navigate pre-set interfaces. This means that many are "free" to use the technology to create their own color images and view images made by others, or they are "free" to renounce these systems, leaving them with close to no other option (save for learning intensive coding or computer science). Such backhanded rhetoric lies at the core of my concept of democratic color. I close this chapter by calling attention to this logic in more detail.

In contrast to painting, film, or photography, with automated computer color there is an aesthetic and ontological gap between the basic material and technical levels of the machine, explained in the previous chapter through the two-tier logic of computing: code and execution; or software and interface. While end users may be able to change the colors on their Facebook page in 0.5 seconds, they have less and less understanding of what is actually going on technically and materially. This speaks directly to the ideological use of terms like "transparency" and "immersive experience," increasingly leveraged in social media and new economy discourses, when in fact the precise opposite of a transparent process is underway: the more user-friendly the interface, the more computational obfuscation and complexity is hidden from the end user. As computer theorist Sherry Turkle puts it, the "meaning of the word transparency has become a new lingua franca. By the mid 1990s when people said that a system was transparent they meant that they could immediately make it work, not that they knew how it works."[102]

This kind of obfuscation, peddled under the guise of "user-friendly" "transparency" and data "sharing" is simply part and parcel of the overarching trend in our networked culture, with its rapidly changing screen technologies. Can you explain how the light blue you see on a Facebook page is generated in the computer, or resonates with and through your perceptual system? The answer involves a host of issues including psychophysics, cognitive psychology, how LCD screens reflect and generate liquid crystals, how signals and electricity move through logic gates, how a color code is processed, and which compiler language is used to process this information. Digital color is bright, fun, and easy to use, but behind their captivating surfaces a whole world exists that most of us have a waning grasp of. As digital color becomes "lighter" and

more "transparent," the capacity to actually control these colors in a way *not* prescribed by commerce or industry becomes opaque, and so too the history they emerged from.

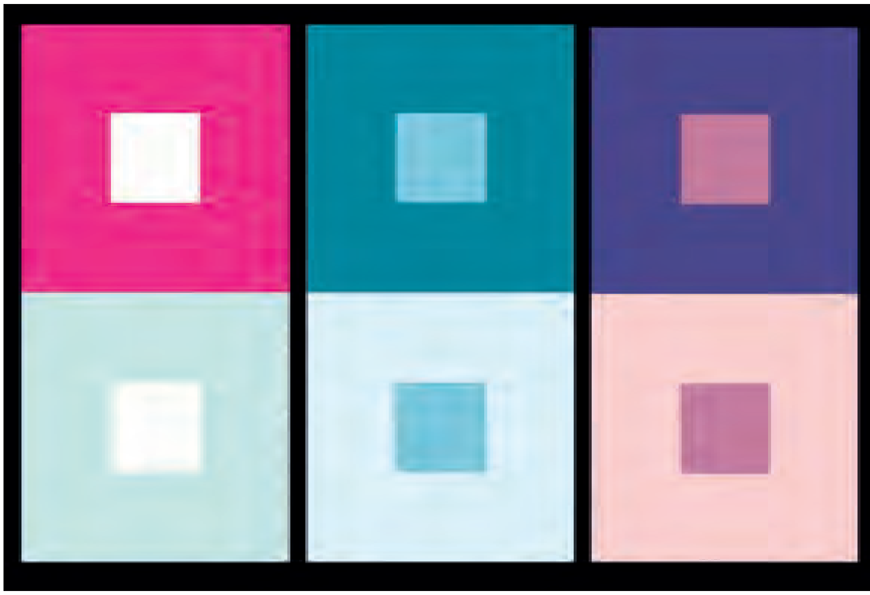
This brings me to another shortcoming: the way in which digital color is represented in operating systems and software interfaces to *deny* differences in subjective color perception. Commercial software applications such as Photoshop, Illustrator, and Flash administer pre-set colors in a pre-set display. Creative choice is limited to clicking on a box that is itself set up in a biased and highly suggestive fashion. The colors in the swatch palette, for instance, are grouped together in small boxes with colors juxtaposed against other colors. This is a problem because colors are relative, so positioning one color next to another will most likely alter both. The effect is what Chevreul called "simultaneous contrast," denoting the way in which a color will look different depending on its neighboring colors (figures 4.13 and 4.14). One of the most dramatic shifts is when one strong hue "pushes" a less dominant hue to the opposing end of the spectrum. For instance, a hot pink next to a cooler grey pushes the grey to appear bluer. These are two of several "shift colors" I have identified in the swatch palette of Photoshop CS6. These laws of color perception are unknown to many users, and one of the most obvious pitfalls here is that the color one thinks one is selecting from the color picker is often not the same color one ends up with.



4.13

Colors also change as eyes get tired. The problem with "today's programs," Schwartz notes, "is that they ignore the perceptual issues . . ."[103] As humans spend more time viewing colors, affective response diminishes, as noted in my discussion of Fechner in the introduction. Furthermore, even the same color image will look dramatically different on each new screen it appears on. Environmental lighting, color calibration in monitors, eye fatigue, differences in individual and cultural perception, the quality of operating systems, printing presses, and web pages, not to mention the life-span of the color guns and phosphors in the screens that generate them, all contribute to color problems in digital media. That these extremely pertinent issues remain unaddressed and unresolved in

4.13 Adobe Photoshop's color swatches continue to place colors next to each other, often resulting in unwanted effects of "simultaneous contrast" where the appearance of a color may shift based on its surrounding hues. In this example, a hot pink pushes the grey towards blue-grey and a pale blue pushes the grey towards a warmer grey.



4.14

digital aesthetics, even for professionals working in the industry, must change in the years to come. Consider the fact that eight percent of Caucasian men are red-green color blind, including Facebook's Mark Zuckerberg.[104] This issue has yet to be significantly addressed in interface, web, or game design discourses though it does (potentially) explain Facebook's primarily blue tonality.[105]

If the goal of democratic user-friendly color is to create an objective color system that users can control and manipulate according to their wishes, then the above listed shortcomings foreclose this possibility from the start. Moreover, the experimental color systems produced at Bell Labs and Xerox PARC during the golden era undermine the possibility of anything like a mass-produced "objective" or "democratic" color system. Effective use of digital color depends on understanding the particularities and nuances of color experience *and* its history in aesthetic computing. This chapter has offered an account of this history in order to counteract some of the naivety and overwhelming optimism surrounding discourses of technical "progress" or "transparency" pervasive in new media discourses.

In this early period of aesthetic computing there was a window, an opening within the yet-to-be. However, as color became accessible, standardized, and available to one and all, the window closed. But note: this window remains closed by *choice*, a choice that has informed future digital technology, which has in turn, determined our contemporary situation of radical "enfaming," as Heidegger terms it. The shift from no color to "millions" of colors (as software packages misleadingly portend) is a story of increased efficiency, severe data compression, commercial motives, and rhetoric. But it is also a story of loss and forgetting: as the visionary, experimental, and subjective aspects of color are

cast aside in a culture driven by speed, efficiency, and profit. During the era when Schwartz produced this work, she noted in her journal that "[a]dvances in technology come from freedom to think." It is also true, as the entry goes on to explain, that "[a]dvances in technology inevitably stagnate creativity."[106] In other words, advances in technology are feats of human innovation that force creativity and artistic practice in new directions. But at the same time, such innovations, like automation and "democratic" color, may result in an abandonment of the incentive for forward thinking and unforeseen innovation with this color. Finally, automated and democratic digital color is not something to be nostalgic about. Great are its affordances, evidenced by the fact that Noll's statement given in this chapter's epigraph is for the most part obsolete.

In the next chapter I continue this experimental history of aesthetic computing by charting the ways in which the development of the frame buffer alongside advances in chromakey compositing led directly into the development of the alpha channel in 1984. Midway through the next chapter I end the book's material history of color in aesthetic computing that I began in chapter 2 and, in the last third of chapter 5, I launch into a stylistic analysis of color in digital compositing in the 2000s by analyzing the tensions between dirt style and the so-called 2.0 look. This stylistic analysis continues through chapters 6 and 7. Broadly speaking, the shift from a material history to a stylistic analysis corresponds with the shift from open, unstandardized, and experimental color systems in the 1960s and 1970s, to the more opaque yet "user-friendly" GUIs of the late 1980s through the 2000s.

4.14 Simultaneous contrast. The inner squares in each column have exactly the same hue, saturation, and value. However, they *appear* distinct due to their varying background colors. In the middle column, for instance, a light blue background pushes the inner square to appear darker and more saturated while the teal background pushes the inner square to appear lighter and less saturated.

Chapter Five

From Chromakey to the Alpha Channel

Using digital media to simulate “rough edges, stains, organic textures [and] grunge-retro fonts” can help one avoid the cliché “2.0 look,” argues British designer Elliot Jay Stocks. Any popular e-commerce or social media website from the 2000s—Facebook, eBay, Twitter, Google—is characterized by this “look” of “vibrant, high contrast colour; gloss; sheen; bevelled edges; gradients; and soft-focus effects (with a subtle outer glow)” (figure 5.1), all of which Stocks finds aseptic and (too) clean-cut, as voiced in his 2007 tirade titled “Destroy the Web 2.0 Look,” presented at the Future of Web Design conference in New York.[1]

5.1

Also in support of anti-aseptic (and even a bit dirty) web design is Russian-born net artist Olia Lialina who, in her 2011 talk “Digital Folklore” given at the New Museum of Contemporary Art in downtown Manhattan, advocated to an audience of hip designers, artists, and critics a future web aesthetic chock full of unicorns, stars, skulls, simple animated GIFs, personal journal entries (she cites one in particular that tracks a man’s battle with depression), and naïve, amateur-looking home pages (figure 5.2). When professional web designers emerged at the end of the 1990s, Lialina explains, homepages were suddenly scorned, becoming a “subject of mockery” in the face of the new slick and streamline designs. This new attitude is illustrated by Russian web designer Artemi Lebedev who at the time included “home pages and their creators” on his hate list, next to “boiled onions and the Caps Lock key.”[2] But for Lialina, going back to “amateur graphics” (and what she has in mind are the web styles and color palettes from the 1990s) resists 2.0’s corporate and professional look, which serves as a disinfectant to personal expression. “We are all naïve users at some point,” Lialina argues, citing web pioneer Ted Nelson, “and we don’t need to be ashamed of this.”[3]

Lialina and Stocks propose aesthetic techniques increasingly popular among net artists and web designers who, fed up with corporate slick, have embraced instead retro-gauche and uncomely remixes; a throwback to what was known in net art circles in the 1990s as “dirt style”: a low-fi, low-cost, simulated-amateur look, here extended to the brightly colored web graphics and video mashups of the 2000s. The 2011 poster for the *Kitsch Digital—Three Decades of Interferences on the Web* exhibition nicely illustrates this retro-dirt style aesthetic: sincere, a bit messy, possibly critical, and always playful (figure 5.3).

A distinction must be made, however, between the “original” dirt style net art from the 1990s on the one hand and the new-school dirt style of the 2000s on the other. The former emerged prior to the dot-com gold rush, exhibiting dirt in part due to technical limitations, because web browsers and video games

5.1 Buttons with precise gradients illustrate the typically clean, smooth, and semi-translucent “Web 2.0 look.”

5.2

were graphically and logistically crude by today's standards, but also for stylistic ones. This first generation includes net artists like JODI, Olia Lialina, Cory Arcangel, and Keith and Mendi Obadike, all of whom sport a "hacker bravado," as Bruce Sterling puts it, in contrast to the new school dirt style's "gooey and ductile" aesthetic; "all [simulated] spray cans and airbrushes."[4] The distinction then is that the latter appeals to a disjunctive and mashed-up look for reasons of *style* and *effect*, not out of technical necessity. Second, the recent dirt style new media art appeals more to, and from within, a context of social media culture, user-friendly software, the commercial Internet, and amateur media production, after the rise, fall, and rise again of the dot-com bubble. Recent dirt style new media art is inclusive of a variety of practices, from net art to mash-ups, glitch aesthetics, data bending, digital error, datamoshing, the work of Beige (a collective of new media artists who maintain "low level" programming in their work), the "New Aesthetic" and "Dirty New Media."[5]

Alternatively, both generations of dirt style may be placed under the broader rubric of postmodern aesthetics or, more narrowly, what Friedrich Kittler informally terms the "aesthetics of interference," by which he implies a set of stylistic techniques that intentionally deploy machine noise, distortion, and clashing elements. In this regard, historical precursors would include the work of artists like Nam June Paik, Dan Sandin, John Cage, the Cabaret Voltaire, and Dada. In fact, when Kittler used this phrase in 1999, it was in allusion

to Paik's distorted and "sloppy" machine aesthetics (see chapter 2 for more on Paik).[6] And while this lineage is an important one, my discussion of dirt style in this chapter is limited to dirt style digital aesthetics and Internet art produced after 2000, and in particular, the digital video and net art of the Paper Rad collective.

What happens then when these so-called anticorporate dirt styles are placed in the broader context of the history of digital compositing in the moving image? Does this history help explain the current popularity of dirt style mash-ups and layering aesthetics as opposed to traditional montage edits? Do such anti-slick "amateur" techniques suffice as critical models? And more pointedly, is it desirable to see a future Internet inundated with (simulated) dirt and loud color combinations that emulate the trashiness of cheap consumer culture, simply because they oppose clean, corporate professionalism? Moreover, do such amateur-looking styles actually *oppose* corporate professionalism, or are they simply the elbow grease, used to ease in the next wave of social-media styles and services?[7] And finally, what does this taste for inaccurate and imprecise media suggest about digital culture and our desires in it?

Fortunately, digital compositing, which is the primary image manipulation technique used in web design and digital imaging, emerges from the history of blue screen and chromakey and through these histories of the moving image electronic color may be used to chart the development of these contemporary techniques and practices.[8] In this chapter I analyze the history of chromakey, from

< **5.2** "Rainbow Glitter." In contrast to the clean-cut 2.0 look, net artist Olia Lialina advocates a dirt-style approach rooted in web glitter and animated GIFs.

5.3 Poster image from the digital art exhibition, "Kitsch Digital: Three Decades of Interferences on the Web," 2011. The image illustrates dirt style's mashed up, kitschy, low-fi aesthetic. Curated by Helena Acosta and Selena Rama of Producción Aleatoria. Barcelona, España.

its prehistory in blue screen through the alpha channel and its instantiation in digital compositing and web aesthetics, or the "2.0 look" and its counterpart in dirt style. Together these narratives help explain how digital compositing–*qua*–remix have become predominant in media aesthetics. In particular, my arguments focus on the way in which pioneering video artist Peter Campus introduced a new approach to electronic imaging *rooted in the logic of space versus time*, which, I argue, foreshadows the logic and aesthetic of digital compositing, linking it directly to the 2.0 look. At the same time, the path connecting Campus' work to 2.0 styles turns on the introduction of the alpha channel in 1984 (made possible after the development of frame buffers and color lookup tables in the 1970s). Once the alpha channel was standardized in computing and easy-to-use GUIs, clean, slick, and corporate-looking designs became normative and antistyle dirt styles emerged. My arguments in this chapter are thus less concerned with the technical history of the GUI or media specificity (I move from film to video through digital graphics and Internet aesthetics) as they are with overall stylistic tendencies that a new generation of artists and digital designers have employed in relation to chromakey and moving image compositing. (For other histories of compositing in art or photography, see endnote 8.)

Finally, the chapter has a two-fold function. As the last chapter in part 2, it adds to and completes the book's history of experimental uses of color in aesthetic computing after 1960. While the synthesizer (chapter 2), numeric color-coding (chapter 3), the frame buffer (chapter 4), and other color systems introduced new and innovative ways to work with color, limitations grew thick and quick. The alpha channel, discussed in this chapter, was introduced as a viable solution to a number of these limitations, especially to the slow and bulky frame buffer. After my analysis of the alpha channel in this chapter, which is to say the advent of fully automated and functional digital color systems for personal use and mass consumption, the chapter segues into a set of stylistic analyses of digital color that continues through part 3 (chapters 6 and 7) and the postscript, where I will have more to say about the significance of this shift into a new style of colorism in new media art in the 2000s.

Blue Screen Window Space

Chromakey is a special effects technique that involves *removing color from an image so that another element may replace it*. In a weather report on a news program the reporter is recorded against a blue or green background, which is then "keyed" out and another image is recomposited into the background, usually with the weather map. In short, with chromakey, color becomes functional: used only to negate itself. A "blue" is useful only to the extent that it can be identified as "blue," not as a visual or optical blue, but as a particular wavelength and frequency that is isolated and removed so the image can function as an element of another composite.

Chromakey is both similar to and distinct from the special-effects technique known as blue screen. Blue screen is a predecessor to chromakey, the primary difference being that blue screen is native to film whereas chromakey is native to video. Blue has long been the color of choice in the film industry because it is the most distinct from human skin tones, making the selection of the human figure from the background much easier.[9] One can use blue screen techniques in video, though the blue often becomes green because, as Fred Barzyk of WGBH notes, too many actors have blue eyes and this becomes a problem for any blue-eyed actor taped against a blue wall (though one wonders if this would not also be the case for green-eyed actors). At the same time, Scott Billups suggests the issue is more about contrast, arguing "blonds on blue, everyone else on green."[10] Because blue is opposite to yellow-orange, green is opposite to red, and all hair pigments besides white-blond contain red, it would therefore be easier to differentiate between foreground and background when one uses green, save for the case of blonds. Further, because all humans contain about 70% red pigment in their skin, regardless of race, green or blue screen is always better than red. But regardless of the nuances of these debates, what is of interest here is the *mechanics* of chromakey and blue screen—how color, as function, is managed and controlled in the moving image.

While chromakey appears, correctly, to emerge from the history of cinema's special effects, it is also dramatically distinct from it, both materially and technically. In order to show this difference, it is necessary to take a brief segue through the development of blue screen in cinema.

What freshman-level film class would be complete without at least a mention of Sergei Eisenstein's famous Odessa Steps sequence in his 1925 *Battleship Potemkin*? The scene is esteemed for its sophisticated use of montage to create a charged dialectic between the Russian peasants and the powerful czar. Eisenstein created the montage by "cutting and splicing" segments of different filmstrips and then reassembling them into a "final cut." Within each of the frames on the filmstrips (twenty-four frames per second in sound film, eighteen frames per second in silent film) the contents remain static. Only a segment or strip of film can be rearranged into a new chronological sequence. This is only one of thousands of montage sequences in cinema, which is to say almost any example from cinema could illustrate how *montage*—which is about arranging elements in *time*—is native to and predominant in *filmmaking*. While montage was a popular editing and effects technique used throughout the twentieth century, its legacy has little to do with the history of electronic color and the new aesthetic paradigm opened up through digital media.

Instead, a second and more pertinent axis running through this history of the moving image is *spatial compositing*, which can be identified in the histories of both film and computing. In computing, what we now call windows, layers, or multiple-tiled sections were first introduced in 1968 by Douglas Engelbart through his NLS (oNLine System) developed at the Stanford Research Institute

(SRI), also the subject of his 1969 doctoral thesis. NLS presented multiple windows through which users could access complex tools for drafting, publishing, email, shared-screen collaborative viewing, cataloging, project management, address books, and all source code development and maintenance. It even included a wooden computer "mouse" that ran on a metal roller.[11] Other similar systems include COPILOT, produced at Stanford in 1974, and the EMACS text editor with windows developed at MIT, also in 1974. Early commercial computer systems that implemented this windows-logic into image-space include Lisp Machines Inc. (LMI) and Symbolics Lisp Machines (1979), which grew out of MIT's Artificial Intelligence Lab projects.[12] The 1981 Cedar Window Manager from Xerox PARC was one of the first tiled window managers, followed by the Andrew window manager developed at Carnegie Mellon in 1983 and funded by IBM. Systems like the 1981 Xerox Star, the 1982 Apple Lisa, and of course the Apple Macintosh, introduced in 1984, further popularized the spatial logic of the window interface on a mass scale.[13] While this brief overview only superficially addresses a few key systems in early computing and demands more comprehensive treatment elsewhere, it nonetheless serves as an important preface to my discussion of the spatial logic in digital compositing.

In film, beginning as early as the end of the nineteenth century, filmmakers sought techniques to *spatially* composite image elements within a single frame. These methods, as Anne Friedberg has noted, involved developing complex mattes and masking techniques and then combining them into one unified image space. To name only two early examples, there is Edwin Porter and Thomas Edison's *The Dream of a Rarebit Friend* (1906), where the directors employed a blurred split-screen technique to depict a dreamer floating over a cityscape, and Lois Weber and Phillips Smalley's *Suspense* (1913), for which the directors constructed a three-way split screen to simultaneously capture three points of view.[14] The unblended composite created a "frame within a frame," a spatial and visual divide within the series of images that were otherwise already divided in time. Another early technique for spatial compositing was the "mirror shot," which used a mirror's reflection to combine images or to project light into inaccessible areas to create superimpositions that could then be used to combine smaller items with larger ones, making irregular shapes appear continuous.[15] Finally, various optical printing and experimental techniques, still used today, allow one to copy one film image, or parts of an image, onto another image through the projection of a master onto copies.

It was not until the 1920s, however, with the introduction of the traveling matte, that one finds a direct link to blue screen. Traveling mattes consist of a transparent piece of film cut into the shape of whatever object the director intends to mask out of the scene. The complement of the traveling matte, referred to as the "holdout matte," stands in for the background of a scene (in digital media, this holdout matte becomes the alpha channel). One of the

earliest uses of a travelling matte is in Linwood Dunn's *Flying Down to Rio* 5.4
(1934), for which he developed a technique to mask portions of the image during an aviation scene, allowing the final image to depict a row of girls dancing on the wing of a flying airplane (figure 5.4). A similar matte is used to mask out the horse's tail in the *Thief of Bagdad* (1940), though in both cases harsh outlines are cut around the elements (when flying through the air, the horse's tail maintains a sharp blue line around it, making the horse look more like a piece of paper awkwardly glued onto the image).

In the 1960s, engineer Petro Vlahos developed several techniques to eliminate this imprecision. He mastered versions of blue screen and sodium vapor (yellow screen) techniques used in *Mary Poppins* in 1964, and in this same year won an Oscar for the conception and perfection of techniques for color traveling matte composite cinematography. In 1976, he founded the Ultimatte Corporation in California, where Polish filmmaker Zbigniew Rybczyński soon joined him.

Rybczyński, for his part, developed sophisticated and award-winning composites *by hand*. Siegfried Zielinski describes him as an "artist-engineer

5.4 Still from Linwood Dunn's *Flying Down to Rio* (1934), for which he developed an early technique to mask portions of the image during an aviation scene, allowing the final image to depict a row of girls dancing on the wing of a flying airplane.

5.5 and cinematographic alchemist," an appropriate description given that Rybczyński's intricate handmade techniques foreshadow digital compositing by at least a decade.[16] For example, *Nowa Ksiazka* (*New Book*, 1975) consists of a screen divided into nine squares (figure 5.5). The action starts in the lower right-hand square and slowly begins to appear in the other squares. At first the squares seem distinct and unrelated, yet they are eventually connected by a jolt occurring simultaneously throughout all the frames. Paul Virilio observes that Rybczyński "uses the image as a series of geological layers. He doesn't play with the image as a foundation of form but rather as a kind of geological stack. Each line being a system that can be isolated in the same way that a geologist manages to study each stratum."[17] Meaning is constructed through associations *between* the image-components in space, not in time, and as a result, the piece offers a new way of reading images—not as a linear or chronological narrative, but rather as a set of components within a larger whole; layered composites, distributed across a spatial matrix.

The originality of Rybczyński's work is clear when one compares *Nowa Ksiazka* to Mike Figgis' 2000 *Timecode*, made twenty-five years later, with all the benefits and flexibilities afforded by digital compositing but which nonetheless employs the same effects technique. Also like *Nowa Ksiazka*, Figgis's *Timecode* uses a quake-like rumble that periodically occurs throughout the frames to create a connection between them. As soon as the tremors settle, each character returns to their own affairs and self-directed concerns. This split-screen technique has become increasingly common in television and film production—Figgis' film is only one example among many—but in 1975 it was still a relatively marginal technique, alongside other examples from the avant-garde and experimental cinema.

Another example is *Tango*, for which Rybczyński drew and painted about "16,000 cell-mattes and made several hundred thousand exposures on an optical printer" (figure 5.6). It took seven months to complete the work, working sixteen hours per day. The result was a symphony of composites; numerous people synchronized to precise degrees as they moved in and out of a small room, seemingly unaware of each other.[18] Pieces like *Tango* and *Nowa Ksiazka* and other similar experimental films that use optical printing (like 5.6

< **5.5** Zbigniew Rybczyński, *Nowa Ksiazka*, 1975. The film consists of a screen divided into nine squares. The action starts in the lower right-hand square and slowly begins to appear in the others.

5.6 Zbigniew Rybczyński, *Tango*, 1980. In this Oscar-winning film Rybczyński drew over 16,000 cell-mattes on an optical printer.

VanDerBeek's early work) are precursors to what has become ubiquitous in digital composting and color grading. Shortly after the film was awarded an Oscar in 1983, Rybczyński turned to video chromakey.

Chromakey: Electronic Compositing

Video is technically, materially, and ontologically distinct from film. If one were to open up a miniDV or VHS cassette tape and begin to cut and splice parts of the magnetic tape to create montage sequences, as filmmakers have done with strips of film for over a hundred years, one would soon find that this hands-on, physical manipulation of the videotape would render the image dysfunctional. Videotape, whether analog or digital, must be manipulated through electronic processing machines. Color information is stored on the back porch of a video signal (the technical term to denote the beginning of each video signal), which can be either amplified or negated, but *only* by way of signal modulation, not physical touch.

A further distinction between *analog and digital* video is mathematical code. When manipulating digital video, one uses a digital computer to compute algorithms that control the image, regardless of whether one is using iMovie, Final Cut Pro, or Avid. However, when using analog video, one may still be using a computer, but there is no transcoding or translation of the electric current into a numeric code to alter the image. Rather, in analog video systems, as discussed in chapter 2, one modulates electronic signals directly. Using a monitor, such as a CRT, an editing deck, panel, or synthesizer, one turns knobs to immediately and directly manipulate the color, measured in frequency and wavelength. For example, blue has a wavelength of 450–496 nanometers, so in order to key out the blue color from an analog signal, one must set the control valve to modulate the signal between 750 nm (red) and 495 nm (green), phase out at the blue levels, and then come back in at 450–380 nm (violet).

Analog keying comes with a host of limitations. First, in isolating the blue in an image, even if one only wants to remove *some* of the blue, *all* of the blue will be removed because the system reads one blue wavelength across the image space, without distinguishing between possible sections of blue. Second, on a technical level, video frames consist of tight diagonal lines that, unlike film, are rendered through an interlaced scanning process where each frame has two fields, divided by diagonal-horizontal lines, each of which is scanned in an alternating pattern at 29.99 or 30 frames per second in NTSC standard. With the advent of HD, interlaced scanning is becoming obsolete as digital video increasingly renders with "progressive scan" algorithms. Regardless, with either progressive or interlaced scanning it is virtually impossible to cut and splice into video frames.

Throughout the 1980s and 1990s, new technical developments like the Scanimate discussed in chapter 2 allowed video chromakey to become commonplace in television shows, music videos, weather reports, and films. Some benchmark projects include John Lennon's *Imagine* (1986), for which Rybczyński built an entire studio space using two blue walls to shoot several sequences;[19] Barry Levinson's famous war fabrication scene in *Wag the Dog* (1997); David Lynch's opening scene to *Mulholland Drive* (2001), a particularly innovative use of compositing to depict alienation in Hollywood (figure 5.7); and Godard's *Histoire(s) du cinéma* (1988–98), for which he used video compositing to show the tensions and contradictions in the multiple histories of twentieth century cinema. 5.7

5.7 Stills from the opening scene of David Lynch's *Mulholland Drive* (2001). This creative use of compositing acts as a metaphor for the characters' alienation.

If traditional cinema creates narrative forms and aesthetic styles through montage, then with electronic compositing, i.e. chromakey, the moving image is fundamentally restructured into an array of color—a matrix of signals—used to manipulate image *space*. The video image, as Manovich notes, shares neither the scale, material logic, structure, nor perspective of the traditional film image. The shift in thinking about the moving image in terms of space versus time, coupled with new developments in electronic imaging, opened the floodgates to a host of new visual styles and simulated environments.[20]

Peter Campus's Three Transitions

With the support of artist residencies at television studios like WGBH in Boston (discussed in chapter 2), KQED in San Francisco, WNET in New York, KTCA in St. Paul, and computer research laboratories like Bell Labs (chapter 4) and the MIT Center for Visual Studies, a select group of artists had been experimenting with chromakey and video compositing since the late 1960s.[21] Nam June Paik, Shuya Abe, Dan Sandin, and Eric Siegel, as discussed in chapter 2, all built their own analog synthesizers to process color signals, which they saw as a vehicle to usher in a utopian future for human and machine consciousness. Throughout the late 1960s and 1970s, the general attitude towards new media, at least in the United States, was "free-flowing, do-anything."[22] There were, however, some individuals who diverged from these normative psychedelic visions to produce highly controlled and deeply conceptual video art. One such person was Peter Campus.

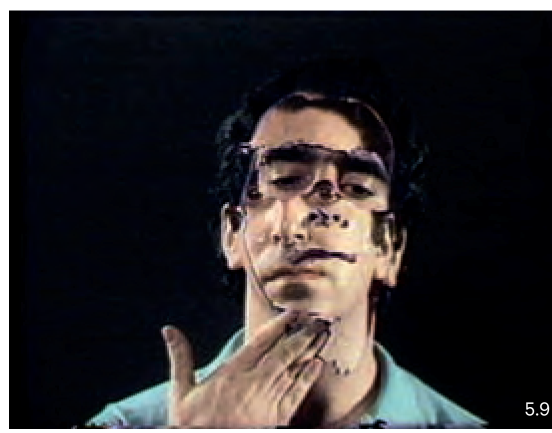
In 1972, Fred Barzyk, then director of the New Television Workshop at WGBH, invited Campus for an artist residency. Since 1966 Barzyk had been running the studio as a venue for artists and engineers to collaborate using such rare and expensive technologies as video cameras, recording decks, synthesizers, switches, and colorizers. Campus arrived with a unique set of ideas about video and its role in the future of electronic art. In those days, according to Campus, artists used video to create one of two things: frenetic and wild composites, as noted above, or "long and rambling videotapes," such as those produced by Joan Jonas, Keith Sonnier, Vito Acconci, and Bruce Nauman, the last of whom remains an inspiration to Campus.[23] Arriving in the art world with a background in commercial television, film, and experimental psychology, Campus could not relate to either of these styles and thus refused to "make long rambling pieces." A testament to this is *Three Transitions* (1973), originally made as a short television commercial consisting of three one-minute intervals to be "inserted as a 'transition' between programs." However, after it was completed it did not get aired on broadcast television as a commercial, as Campus had planned. WGBH told him, "'Well, there's no way that's going to

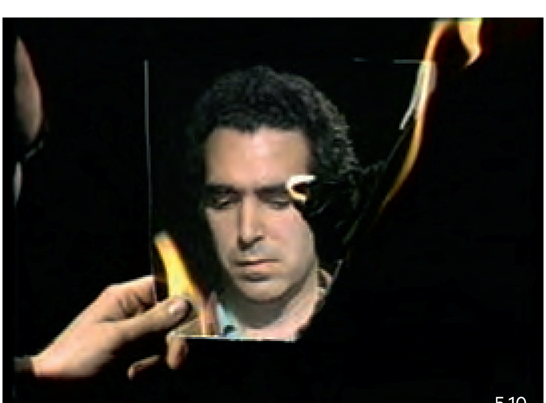
happen.' They just wouldn't allow it. The station thought they were too weird."[24] It was instead broadcast as a single piece, during a show on "the arts."

In its current form, *Three Transitions* is a six-minute video divided into three short sequences, the first of which uses superimposition and the second two, chromakey. In the first transition, Campus stands in front of a flat yellow screen with his back to the camera. Using a large knife, he cuts through a wall-sized piece of yellow cardboard and as he cuts, the knife appears to be cutting through his body from behind (figure 5.8). The second sequence opens with a close up of Campus' face looking directly at the camera. His fingers begin to touch his face and with each touch he removes a part of his face, or so it seems. As he brushes his fingers over the surface of his skin another face is revealed behind it (figure 5.9). In the third transition Campus holds a photograph of himself, which he then lights on fire, holding it up to the camera as it burns. As the paper burns, the image moves, as if he was burning himself alive (figure 5.10).

Central to Campus' technique is a *shift in thinking about the moving image as a series of frames to be edited in time (montage) to image-components that can be manipulated in space (compositing)*. Some of this is prefigured in Rybczyński's and Vlahos' work, and the earlier uses of blue screen mentioned above.


5.8


5.9


5.10

5.8 Peter Campus, *Three Transitions*, 1973. Video still. Early superimposition techniques are used to carve out video space. Courtesy of Peter Campus.

5.9 Peter Campus, *Three Transitions*, 1973. Video still. Campus' original use of chromakey depicts the way in which new image-layers emerge at the point where he applies blue paint to his face. Courtesy of Peter Campus.

5.10 Peter Campus, *Three Transitions*, 1973. Video still. Chromakey is used to create the illusion that Campus is burning a live image of himself. Courtesy of Peter Campus.

But note that Campus is using chromakey in 1972—a decade before Rybczyński started to use it. Furthermore, with chromakey the shift from temporal cuts to spatial composites is almost prescribed through the material logic of video, a real-time signal processing medium. Campus's work helps us to see the transition in moving image aesthetics from time to space because it forces us to see chromakey as a *material* and *formal* technique of real-time signal processing and *not* as a mere effect that poses as its own content, which is how many of the psychedelic video artists approached it. Moreover, as both Lev Manovich and Anne Friedberg have observed, spatial compositing did not become dominant in mainstream media practices until the 1990s, and thus in Campus' early work one finds a valuable and generally unacknowledged predecessor.

As I note above, chromakey is about removing part of an image, thereby negating color in its phenomenological and sensory form and asserting instead color as an image *function*. In this process, color-as-function turns a so-called image into a dynamic system with subparts connected to a larger whole. This occurs both materially and aesthetically. Materially, because an electronic "cut" is not really a physical removal but a *modulation* of an ongoing series of signals that can be reduced or amplified at any point. For example, in the first transition, when Campus takes a knife and cuts through the wall-sized cardboard, he has already conceived of the final image as two semitransparent layers. During production, two images of his body are recorded, one shot from each side of the wall. In the final image they are superimposed onto each other, making it appear as if he was cutting through his own body. While this is not an example of chromakey, the transition is about approaching the electronic image as a set of malleable parts that can be modulated and manipulated as (virtual) layers in space. As a result, the final composite attains a liquid and ephemeral quality, further emphasized in the second and third transitions, which do involve chromakey.

For the second transition, Barzyk explains:

> [Campus] asked me to record a videotape of his face just looking forward . . . then play that videotape back and then live on camera, chromakey in the picture that had been prerecorded. . . . He started [applying the blue paint to his face] wherever a piece of the other image would show up . . . He was watching on a monitor, so he was constantly checking how he could get his mouth and his eyes lined up with the other image.[25]

The specific location of any blue paint in the third image was fed back into the first prerecorded image. The blue *was* the space where the formerly distinct images met and transformed into a system, a feedback loop that literally transfigured time (the recoded image) into a function of space, or "layer" in the resultant composite. In this way *Three Transitions* figures as a precursor to spatial compositing aesthetics much more so than to the psychological tropes of video narcissism that the piece has otherwise been connected to.

In fact, in stark contrast to those who have written about this work by invoking psychology, Campus claims no special purchase on the subject. The most noteworthy example is art critic Rosalind Krauss's essay, "Video: The Aesthetics of Narcissism" (1976).[26] In this groundbreaking essay, Krauss analyzes several installation, performance, and video artworks from the late 1960s and early 1970s, including Richard Serra's *Boomerang*, Joan Jonas's *Vertical Roll*, and installations by Bruce Nauman. She aligns the video medium—through its capabilities for real-time feedback and signal processing—with the psychological condition of narcissism. Narcissism, in Krauss's account, refers to the way in which a video artist's or performer's body is situated in the circuit between monitor and camera. When the circuit is turned on, one's image is reprojected on a cathode-ray tube and like a mirror reflects the "self" back to oneself. As a result the subject severs all relations to the past or future, creating a closed system wherein one is looped into the hypnotic, auto-amputated spell of one's (misrecognized) self-image.[27] Krauss concludes that "narcissism is so endemic to works of video," it may be "generalize[d] as the condition of the entire genre."[28]

Campus's work is discussed in the last few pages of Krauss' essay. She focuses on his early pieces: *mem* and *dor* (both 1974)—two installations consisting of a triangular relationship created between a video camera, an instrument that will project the live camera image onto the surface of a wall, and the viewer in front of the wall—which, Krauss argues, "acknowledge[s] the very powerful narcissism that propels the viewer forward and backward in front of the muralized field."[29] Because *Three Transitions* also includes a real-time feedback loop, the artist-performer placed at the center, and the use of video chromakey as a mirror to guide the artist within the image-space, the piece structurally and formally meets the requirements for Krauss' analogy to narcissism. And indeed, after Krauss's pivotal essay, critics analyzed Campus's work, and *Three Transitions* in particular, in terms of the psychology of narcissism. Martin Friedman, for instance, wrote in 1979 that "[w]hile exploration of [the] psyche is certainly the essence of many contemporary artists' approach, Campus carried this to obsessive extremes, particularly in a series of psychological self portrait video pieces made in the early 1970s."[30]

The problem with the theory of video and narcissism, however, is twofold. First, the argument turns on an almost imperceptible but nonetheless problematic merger between video art and the norms and conventions of art history. Unlike the history of new media or computer art, in formal art criticism it is normative to speak about an artwork in terms of "re-presentation" and the "internal qualities" of a medium or an "image," in relation to older re-presentational media. As Krauss puts it, Campus' work uses "the [video] medium as a subspecies of painting or sculpture."[31] John Hanhardt and Maria Christina Villaseñor writing in 1995 concur that *Three Transitions* "extend[s] the convention of self-portraiture and the illusions of representational image making through

the unique properties of the [video] medium."[32] But *extending* the representational discourses of painting, sculpture, and photography through video is not exactly what Campus was hoping to accomplish with *Three Transitions*. In fact, his goal was to obliterate them. With each of the three segments, Barzyk explains, Campus' "whole point was to go from painting to sculpture and photography and argue they were all going to be wiped out because of video."[33] The first sequence, for instance, takes a knife up to the "canvas" and cuts through both the support and the artist who uses it. With the second sequence Campus was trying to "give an electronic sense of being three-dimensional, by having two faces . . . he was sculpting with the chromakey," showing how electronic color modulates—i.e., sculpts—virtual space in ways superior to, and more flexible than, sculpting in physical space. In the third sequence, Campus sets the blue piece of paper on fire, communicating how "he was going to get rid of photography, so that you are left only with electronic video."[34] *Three Transitions* broke from these "representational genres" conceptually and materially (though arguably such a break could also affirm a connection).

Second, in order to accept the link between video and narcissism, one must also accept the hermeneutic presuppositions of Western psychology and with it, its theories of the liberal-humanist subject. In contrast to humanism, and as I have argued previously, humans exist in and through technics and must therefore be approached and understood through the technologies that we use and develop, and which in turn create us. Moreover, because video is a form of (analog) computing, it needs to be interpreted through the material critical frameworks opened up by cybernetics, and subsequently the redefinition of the human that accompanies it, a process that I call "hyperdividuation."

Hyperdividuation

My concept of "hyperdividuation" performs a double labor: denoting both a new kind of techno-subjectivity that draws on the material logic of cybernetics and information circuits, and second, a subsequent shift in sociality and socially mediated practices. Beginning with the first, cybernetics, as noted in the introduction, involves the study of communication systems in humans, animals, and machines and holds to two guiding logics: feedback and information processing.[35] The former, central to *Three Transitions*, opens the door to an analysis of the human and the machine as interwoven systems, versus traditional "depth" models of the individual and autonomous ego or psyche. In a video feedback circuit a subject is mechanized, becoming a relatively anonymous node within the larger system. The emphasis shifts from a distinct observer-subject looking at a visual image (object)—a precondition for narcissism—to an immersion and dissolution in the system.

As pioneering cybernetic-video artist Paul Ryan puts it, in a video feedback loop, one transmits false notions of an interior "self" into the (externalized) video loop in a process of "self-cybernation." Ryan's work with *Radical Software* and Raindance in the late 1960s revolved around the figure of the Moebius strip, which encapsulates the process of infolding intrinsic to the feedback loop. In the "Moebius Strip," Ryan writes, "the outside is the inside. The inside is the outside."[36] In a video feedback loop, as with cybernetics, the metaphysical distinctions between subject and object collapse into a kind of techno-ecosystem. Similarly, Katherine Hayles argues that with cybernetics, subjectivity becomes a hybrid human and machine reality wherein virtual and actual are deeply intertwined and to some degree indecipherable: "feedback loops between culture and computation create a co-evolutionary dynamics in which computational media and humans mutually modify, influence, and help to constitute one another."[37] Experience is instantiated *through* human-machine interaction, not before or after. In cybernetics and video feedback, no single term, object, or identity is prioritized or given meaning exclusive of or prior to the system.

If a subject cannot be prioritized, then neither can his or her self-image, which of course depends on *visual* perception and as such, it is the essential ingredient in the psychological myth of Narcissus. In the myth, metaphysical delusions are bolstered by one's *imago*, or visual reflection, *and nothing else*, which is to say, through an exclusively optical and visual regime. In contrast, with electronic systems only a degraded and highly mediated "self" is made possible *after* one has entered the (cybernetic) feedback loop and post-optic information exchange. (In the next chapter I further elucidate and theorize the distinction between the optic and post-optic.) Ryan explains, "I would avoid the term visual to describe video . . . [with] video images the effect is primarily kinesthetic or proprioceptive . . . Video is about perceiving events with the nervous system, not visualizing in a pictorial way."[38] Video is first and foremost a cybernetic system, not a visual or optical medium (as I argue in chapter 2).

Krauss's theory of video and narcissism, which depends on visual, psychological, and humanist theories of the individual, may now be supplanted by a set of metaphors more appropriate to cybernetics and aesthetic experience in the information age. For this I propose "hyperdividuation." Hyperdividuation does not imply a fragmented or poststructuralist, schizophrenic subject, but instead a depersonalized subjectivity actively recomposed (and composited) through disjunctive human-machine exchanges in rich, socially mediated information systems.[39]

Because cybernetic splitting and hybrid subjectivity are progressively amplified in newer new media—through the Internet, cell phones, RFID tags, PDAs, social media, and screen technologies—I adopt the word "hyper." Similar to Hayles' theorization of "hyper attention," my use of "hyper" in hyperdividuation denotes a doubling of attention systems, a "switching focus . . . between

different tasks," which is characteristic of a subjectivity that now prefers "multiple information streams," seeks a high level of stimulation, with a "low tolerance for boredom." But instead of classifying such habits and behaviors as "disorders," for which medication is prescribed, I want to here highlight the positive and productive attributes of these subjectivities (however, in chapters 6 and 7 and the postscript, these same attributes are subject to a much darker critique). For instance, two benefits to hyper attention, Hayles explains, are increased "environmental alertness and flexibility of response," both of which are beneficial traits and coping mechanisms in a world that demands constant surfing, remixing, and compositing of data streams and realities. Hayles also contrasts hyper attention with "deep attention," a cognitive style associated with "concentrating on a single object for long periods," or, in terms of aesthetics: a single static image interpreted by a self-reflexive individual; a so-called master of his or her own (ego) reality.[40] In contrast to theories of the autonomous, self-sufficient individual, hyperdividuation is extra-ordinarily fragmented and dispersed through space, time, and media situations.

Stiegler's discussion of psychic and collective individuation, as linked to the notion of "attention," is also applicable to hyperdividuation. For Stiegler, attention could mean care, simply paying tribute, and more often than not, the externalization of history and experience into technics and specific technologies referred to as *attention forms*, which link psychic and collective individuations: "attentional forms generate the circuits of transindividuation that thread and weave together the process of collective individuation." Attention forms are conditioned by material techniques and especially through "industrial technologies" beginning in the modern era. For Stiegler, attention forms seem to replace media specificity. In the current age, he writes, our "attention and relational technologies develop via *folksonomies*, that is, collaborative metadata."[41] Hyperdividuation then is also an offshoot of Stiegler's broader concept of attention forms that mediate between individual and collective, here applied exclusively to new media interfaces and digital imaging practices.

The second part of the term hyperdividuation—"dividuation"—draws from phenomenology to invoke broader shifts in technically mediated social relations. Heidegger's phenomenology, for one, offers a view of the subject grounded in material fact, not in psychological ideals, ideas, or essences. Being is always already in the world. For Merleau-Ponty, it is also only through the qualitative, factical being of an anonymous and depersonalized sensory consciousness that existence is accessed or known:

> If I wanted to render precisely the perceptual experience, I ought to say that one perceives in me, and not that I perceive. Every sensation carries within it the germ of a dream or depersonalization such as we experience in that quasi-stupor to which we are reduced when we really try to live at the level of sensation.[42]

The "facticity" of matter (*hyle*) is privileged over theoretical abstraction or ego-identity. Anonymity and depersonalization become the basis for life experience in what I have called the algorithmic lifeworld.

This active exchange between (collective) world and being is also what makes hyperdividuation sympathetic to Bernard Stiegler's 2009 theory of individuation as "phase-shift." To formulate this notion, Stiegler turns to Gilbert Simondon's concept of "transductive relation," which is, as Simondon defines it, "that which opens up possibilities of internal resonances in a process of psychic and collective individuation." Simondon's concept appeals to Stiegler because it allows him to think of individuation *as a formative process* that occurs *through* constitutive tensions between the individual and the group.[43] Stiegler uses the concept to reread Heidegger's existential analytic of Dasein as neither "denigrat[ing] the collective" (the "they") or "as a decision limited by being-towards-death." The "they" that Heidegger appears to dismiss in Stiegler becomes a normatively positive "we." Collective experience comes from individual experiences that have become collective through a process of *transindividuation*.[44] The result—unbeknownst to either Heidegger or Simondon—is Stiegler's "transdividuation," an individuation characterized by a "*composition* of forces"; a composed and composited "transdividual" that provides a theoretical correlative to my notion of hyperdividuation.[45] In other words, there is an ongoing exchange (mediation) between the individual and the collective in order for *transindividuation* to exist.

Finally, my use of "dividual" in "hyperdividuation" is inspired by Gilles Deleuze's and Simon Critchley's uses of the term. While they both use it in distinct ways, the hybrid (composite) version would be something like an anonymous, informatic subject who is consistently divided—falling and failing—in the material world, but nonetheless alive and dynamically engaged in feedback loops, data exchanges, and organizational patterning. My Deleuzian-Critchley composite is also responsive to an "infinite demand," as Critchley puts it, not so much in terms of ethics but in the accelerated physiological, psychological, and processing demands placed on life in an information-intensive lifeworld.[46]

Hyperdividuation is thus a philosophy of technology and a technical being-in-the-world with others that complements material shifts in new media production, ones that will only become increasingly common in the years to come. "The person of the future," Flusser writes in 1985, "will be absorbed in the creative process to the point of self-forgetfulness." But at the same time, he warns, it is "wrong to see this forgetting of self as a loss of self." To the contrary, the subject of the future is not an ego-driven subject but instead a self that gains being through creative performances at "the keyboard," which is to say, when and where the self (Stiegler's "who") becomes collective (the pejorative "what"). In this process, the new subject, the former "I" of the "eidetic reduction," Flusser writes, "will be realized for the first time"—a provocative

though perhaps uncritical statement implying that blanket positive or negative evaluations must be suspended (which Stiegler's "what" fails to do) and that a true transcendental reduction—the sustained reality of the mystical visions of video synthesis circa 1969—will in the future be realized (not just theorized, as Husserl did) through technics.[47]

Before linking hyperdividuation to dirt style compositing in my conclusion, we must first move through the digital instantiation of chromakey in the alpha channel.

The Alpha Channel

The three primary colors of any additive (light-based) color system, such as a computer monitor, television set, projector, or rainbow are red, green, and blue (RGB). Any other color that appears on or in these media is always a combination of these primaries. In digital computing, each color is indexed by a numeric value in a lookup table (LUT). When this value is sent to the display terminal, it is translated through a frame buffer (the history of which I provided in the previous chapter) that translates color values into pixel values (or "point samples") that can be rendered on a video screen or monitor. Contrary to common thinking, a pixel is *not* the little square one sees when one zooms in on a graphic.[48] This myth derives from computer graphics practices in the 1970s, in the era before the frame buffer, when images were clunky, difficult, and time consuming to render. Throughout the 1970s, the main problem with frame buffers was their incredibly slow line-by-line rendering process (essentially a one-to-one correspondence between screen color and pixel value). As Richard Shoup describes the situation, "[i]n raster scan display systems . . . the cost of providing animation has usually been prohibitively high due to the large bandwidths involved in changing a picture rapidly."[49] Further, the results of this slow and time-consuming process were inelegant and produced images with jagged hard edges (known as aliasing, or "jaggies"), which often got mistaken for a line of "pixels." Jaggies are the result of poor rendering algorithms, and most engineers, scientists, and artists—with well-noted exceptions—do not like them very much.

In 1975, Ed Catmull, who would eventually become the president of Disney and Disney's Pixar, was working at the New York Institute of Technology with Alvy Ray Smith, where they were using a 640 × 480 × 8 bit frame buffer to render computer images. In 1975, the device cost $80,000 and NYIT was one of three or four facilities in the world that had such a device (Bell Labs was one of the others). In spite of its state-of-the-art status, Smith was not pleased with the length of time it took to render a single image and how frustrating it was if, after rendering an image he wanted to change one tiny detail, he needed to render the entire thing over again. Catmull agreed. He suggested they develop a technique to

“render the opacity information *with* the color information.” This way the information could be stored together in a file that could then be composited over the background so the other parts could be altered without rerendering the whole thing.[50] To accomplish this they needed to add another channel to the three-channel (RGB) image; so RGB became RGBA. In a thirty-two-bit graphics image, for instance, there would be four channels—three eight-bit channels for red, green, and blue (RGB) and one eight-bit alpha channel (A).

The alpha channel, while not fully functional until 1984, is premised on the logic of relative opacity and transparency. The alpha channel consists of a set of algorithms used to create a digital matte that preserves a range of transparencies (opacity levels) at each image point and for each red, green, and blue channel in the image. If an alpha value is 0, this means that the pixel is transparent. If the alpha value is 1, then the pixel is opaque.[51] The analog to the alpha channel is the holdout matte discussed above, and it should come as no surprise that for inspiration Smith turned to Petro Vlahos' early blue screen patents, forging a direct link between the spatial logic of blue screen and alpha channel compositing.[52] However, where the classical problem in film compositing was how to separate a nonrectangular foreground image from a rectangular frame, the problem *and solution* in digital compositing was how to use mathematics in the form of algorithms to control color in a virtual “image” space.[53] Smith further improved the alpha with his development of the premultiplied alpha (also known as a sprite in animation and gaming), which allowed for the premultiplication of color information prior to rendering.[54] The fully functional alpha channel greatly reduced processing time, saving memory and storage space and thus labor.

If chromakey transforms optical and sensory color into a function of electronic space, then the alpha channel furthers this by making the algorithm the controlling agent in determining each pixel's relative opacity, that is, whether or not a color *will exist*. In fact, Smith and Catmull gave their algorithm the name “alpha” after the Greek letter to indicate its new dominant role in computer graphics. The new dominance of the algorithm, however, does *not* mean that algorithmic color now controls the digital image, privileged over and against form and structure (which would mark a radical and unprecedented reversal in the longstanding debates between *colore* and *disegno* and Western chromophobia in general); rather, it is at this juncture that color *and* form become algorithmic. The algorithm controls not only what color will be possible but also the shape and form of the so-called image.[55] In other words, in digital media, algorithms trump both *colore* and *disegno*.

Once frame buffers and alpha channels could be programmed to consistently composite smooth and clean edges in color digital graphics, the technique became extremely attractive to industry and the inelegant and bulky jaggies, or flaky black edges unavoidable in Campus's work, were a thing of the

past. This happened throughout the 1980s and 1990s, with such systems as the 1986 Quantel Paintbox, which cost over $160,000 (which meant that many could not afford it), or Harry, the first all-digital, commercial non-linear editing system, also manufactured by Quantel in 1985, which allowed users to digitally composite multiple layers of video (eighty seconds maximum due to hard drive limitations). The Avid system, first released in 1989, and other related systems also contributed to this shift. However, their relatively high cost still made it prohibitive for many, save for network television stations and a few well-off production houses.[56] And thus Hollywood was among the first to welcome digital compositing: Lucasfilm used it in all films after 1982, Pixar in all films after 1986, and Disney in such films as *Beauty and the Beast* (1991), *Aladdin* (1992), *The Lion King* (1994), and *Pocahontas* (1995).[57]

By the late 1990s, inexpensive graphics workstations and personal computers were introduced en masse and clean composites became the norm for consumers and producers alike. This occurred through technologies like video cards in the Amiga computer and the Apple II computer, which came equipped with a low-level color frame buffer; Photoshop software (version 1.0 was first introduced in 1990); and After Effects, a software introduced in 1993, designed to manipulate moving images through a multiple windowed, spatially oriented interface (versus the linear timeline).[58] As digital artists, media producers, and designers increasingly took to color video and graphics programs, a shift in the aesthetics of the moving image was under way. Alpha channels became normative in computer graphics and video software, and digital color became synonymous with flexibility and "choice," echoing the rhetoric of "freedom and democracy" surrounding Internet and the new frontiers of "cyberspace." But then something unexpected happened: these vast new "freedoms" and "choices" that "revolutionized" color and the moving image in the 1990s led to a *homogenization* of style and creative production.

While hardware and software do not directly determine what an artist, filmmaker, designer, or user can or will do, it is undeniable that the structure of an interface and its windowed layout strongly suggests certain uses and influences one's choices. What resulted from the new market saturation of color and compositing software applications was a host of work that simply used the same automated effects, or alternatively, used effects with little to no value placed on meaning. In other words, new media and digital effects ended up looking either template-driven or like superficial eye candy, neither of which indicated an actual revolution. Lev Manovich observed a similar phenomenon in digital cinema between 1993 and 1997, which he characterized as the "velvet revolution" because of the way in which the new software was used to gather disparate media sources and, almost universally, reunify them back into a smooth and seamless, coherent whole.[59] Because the web "2.0 look" emerged in the early 2000s, after Manovich's analysis, I here extend his observations to it.

The "2.0 Look"

After the dot-com crash in the fall of 2001, media producers and industry professionals needed to find a new set of seductive yet commercially viable Internet applications. The result: the 2.0 business model, now considered the winning ticket for any e-commerce architecture or interface design. As a business model, web 2.0 specializes in e-commerce, mainly through social media and user-generated content (like Wikipedia, eBay, or Facebook) and places a premium on human-computer interaction. As Tim O'Reilly puts it, "Web 2.0 doesn't have a hard boundary, but rather, a gravitational core."[60] In 2009, the search term "Web 2.0" produced 9.5 million citations in Google. In 2013, long after the height of its supposed fashionability, it returns 2.4 billion.

And despite claims to the contrary, 2.0 does have a "look," which, as noted, is characterized by "vibrant, high contrast colour; gloss; sheen; bevelled edges; gradients; and soft-focus effects (with a subtle outer glow)." The look should be seen as an extension of modern design principles, especially the principles of elegance and simplicity in regards to line and shape, and specifically in reference to modern design movements like the Swiss International style and the Bauhaus aesthetic, both of which seek increasingly clear and comprehensive means to deliver visual messages, here filtered through market research and postindustrial corporate "cool."

But this 2.0 cool is also cold. "Strip away the colorful metaphors of information seas, webs, highways, portals, windows, and the rest," writes new media scholar Alan Liu, and "what comes into view is the stark cubicle of the knowledge worker." Today's innovation manager—"designer" rather—is encouraged to "think outside the box," to adopt a production code of "innovation," and what has been coined by these innovation industries as "creative destruction." The "creative" knowledge worker must "push the boundaries," always be on the cutting edge of the "new" and perpetually cool, but "not so cool as to actively rebel or quit," Liu writes, "just cool enough to be slightly kinky in the web pages [one] browses at work . . . not quite subversive, but [exhibiting a] behavior that asserts 'I'm me' and not just part of this corporation." The knowledge worker's prescribed ethos of "creative destruction" thus places less emphasis on actual destruction, favoring instead the "creative"—which is to say, creative thinking, but thinking that *must* occur within the increasingly narrow parameters of the postindustrial political economy of the so-called "worldwide" web.[61]

Now fused into a single, parsimonious continuum, Liu continues, this worldwide web couldn't be further from its self-proclaimed Enlightenment roots and ambitions for an ever-upward "progress" in which all domains of life—intellectual, social, economic, and cultural—improve together. To the contrary, this worldwide web instantiates only the most "hostile take-over of life at large" by rational-economic subsectors more accurately called corporatization, streamlined and packaged as "globalization." As the "global" web continues

to cast its net over its users and workers, obfuscating its limits, boundaries, and prescribed forms of social and intellectual behavior, one confronts real coldness—remoteness, distantiation, and impersonality—emerging as the dominant tropes of our time.[62] Liu's analysis highlights how the so-called "user-friendly" 2.0 look echoes the veneer of information-cool, meanwhile trafficking existential cold.

And moreover, for all its seductive allure, the 2.0 look disavows a basic fact about itself: because it is a digital medium, there is a paradoxical relationship between its operating system and its interface. Around 2007 many 2.0 websites such as MySpace and YouTube channel pages offered users opacity features to easily and efficiently alter the transparency of various objects or boxes on their pages. This no doubt marked the arrival of the alpha channel, streamlined for fast and efficient web content. But rather than give users a more "transparent" experience, or comprehensive account of how these effects are operating, this new feature simply meant users have *less access* to the logic of the operating system and its algorithmic codes. The smooth 2.0 aesthetic is thus a façade, an interface, leading one to perceive and celebrate the Internet as a simple, transparent, and "cool" modernist utopia, filled only with the sanctified spaces of formal-rational purity, void of glitch, error, or "purely expressive colorfulness," as Ernst Bloch puts it.[63] For the 2.0 style, as it is with Western chromophobia, bright and expressive colors are tolerated so long they are controlled within a clean and rational design, held together in a sturdy rectangular frame.

It is also helpful to consider this new affect of cool as parallel to what new media scholar Adrian Mackenzie terms—albeit in a slightly different context—the "affect of efficiency." Here, clean lines and graphics can be seen as analogous to clean and efficient work habits, sanctified lifestyles, and vapid forms of cultural production. Together, the two reflect how the ideology of "creative innovation" and the eternal "new"—typified in the nominalization of anything "2.0"—have been so deeply co-opted, rationalized, and micromanaged by industry, business, and the information economy, Liu argues, that they have become meaningless. "Insofar as the avant-garde is exhausted and dead," the truly new art must "propagate within [its] corpse" through another kind of "destructive creativity" that acknowledges the "elegant harmony and transparency" of "cool" immaterial information as a *fiction*, accepting instead disturbance and noise as inherent in the *matter* of the medium. If destruction is inevitable in every creative act, Liu asks, then how can one do a better job of managing that destruction so as to "blunt its worst tendencies and, despite itself, to evolve emergent, new ways of sustaining what the classical philosophers once called the 'good life'"?[64] That is, how can we use and experience new technologies to create a sense of ethical responsibility to the self and community. But is this even possible within the domains of the

proprietary net and if so, what would it look like? In the next and last part of the chapter, I consider whether or not Paper Rad, as an example of dirt style new media art, fulfills this mandate.

Dirt Style and Paper Rad

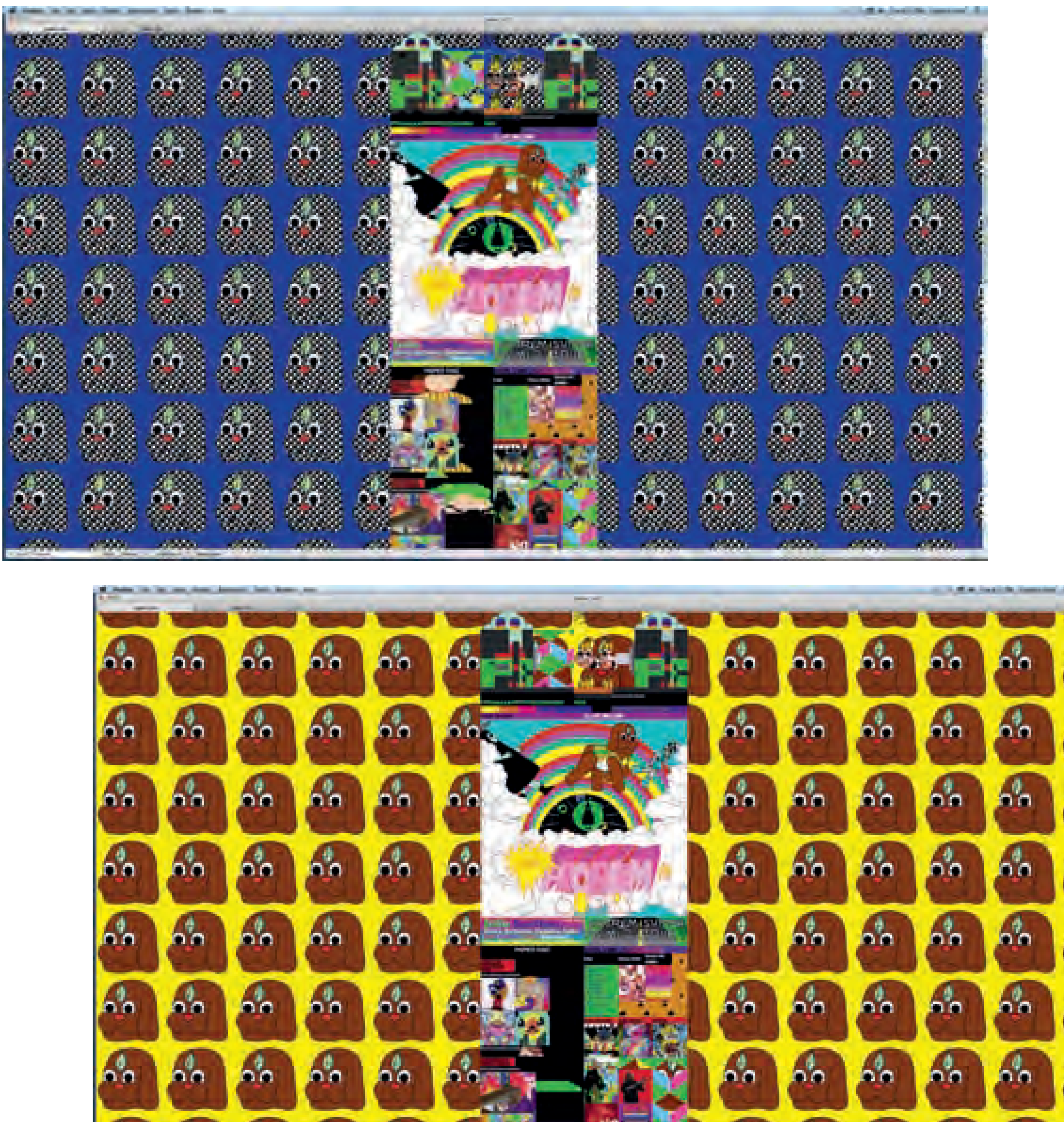
> Sean Bieri: Does Paper Rad follow any rules?
> Jacob Ciocci: YES. Groove is in da heart.
> —2008

Recall the bulk of web designs from the early 1990s: constantly changing hyperactive visual elements, shocking and unexpected uses of garish color, asymmetrical shapes and layout, crude HTML (tiling, jaggies, and framesets), and inconsistent page renderings with different browsers. In short: everything *but* cool and controlled, austere design. Significantly, these techniques emerged after the advent of digital compositing for video, which, after migrating to the web, eventually grew into the more "sophisticated," or at least smoother 2.0 look and remix culture in the 2000s.[65] Insofar as contemporary artists and designers, including Olia Lialina, Cory Arcangel, Beige, Lo-Vid, Rosa Menkman, Oliver Laric, Petra Cortright, and Paper Rad *intentionally* and *self-consciously* re-apply the earlier conditions and techniques of web design and digital media to their work in the 2000s and 2010s, the dirt style aesthetic is here extended to their work. And, as rich and varied as these artists' techniques are, I limit this chapter's concluding discussion to the fast-paced, DIY, hyperanimated color composites in key examples of Paper Rad's digital video and net art.

Paper Rad is an east coast art collective that emerged in the early 2000s, alongside other DIY punk-art and noise music movements from Providence, Detroit, Baltimore, Boston, and towns in western Massachusetts.[66] Using raw materials from pop culture, television, performance, clothing, cardboard, and vegan chocolate, the collective has since been individually and collectively making music, cartoons, "cable tapes," comics, zines, video art, installations, net art, and paintings, always decked in kaleidoscopic hypercolors, heavily dependent on digital compositing and hybrid media techniques. And while a number of the original members have since moved elsewhere to form the group Dear Raindrop, the three current core members include Ben Jones, and brother and sister Jacob and Jessica Ciocci, all three of whom grew up in New Age households and as a result their work is chock full of "rainbows, peace signs, unicorns, pyramids, crystals, and mystic gurus," though not without a heavy dose of satire.[67]

Paper Rad's aesthetic, in the words of Johanna Fateman, is "content-rich, arcade-like, bad html web mall," or, as the *New York Times* puts it, "tripped-out children's television." And Johnny Ray Huston writing for the *San Francisco Bay Guardian*: "seizures of pleasure."[68] Key examples of Paper Rad's work include

the collective's web site and home pages from the early 2000s. During this time, "Paperrad.org," New Museum curator Lauren Cornell writes, was by no means an "easy-to-navigate online artist's CV." Instead, it "function[ed] more like a maze of found, remixed, and original content."[69] On their 2008 home page, for example, one finds an oscillating yellow and blue background filled with tiled heads of Paper Rad's fictional character, D-O-G appearing in either his regular brown or a black and white checkered pattern[70] (figure 5.11). In the middle of the page is a frameset-style display box with information about



5.11

Problem Solvers, their 2008 kids cartoon about six fictional cartoon characters, created with built-in commercial breaks in a half-hour format with a "post-hippy new-age message."

Problem Solvers also illustrates Paper Rad's hyperchromatic mashup aesthetic. The piece was made "for everybody," just as their digital compositing and appropriation techniques are the same ones used "by everyone" in today's remix, "amateur" media culture.[71] But unlike everyone who remixes and mashes up media, and also unlike most kids cartoons, by the end of *Problem Solvers*, the characters have eaten psychedelic peace sign–shaped pizzas (generated by a computer that catches rainbow signals from the air), entered a time warp, and dreamt communal cosmic visions inside a multicolored patchworked-geodesic dome. The characters' psychedelic adventure, however, does not yield deep-seated mystical visions, as it did for those artists and technovisionaries discussed in chapters 1 through 3, rather, Paper Rad's characters merely come to the banal realization that the solution to their problem—that "there is something missing"—is to change what they order for breakfast. And what is the new item they select from a fast-food-style menu on the wall? "Dog's Special," followed by Peppermint Tea, deemed "good for soul," as chanted in a groovy soundtrack that brings the episode to a close.

What I have referred to as hyperdividuation is instantiated in *Problem Solvers* through the characters' affect and their colorful hypermediated daily experiences, ones that are clearly "chewed up and spit out" from the "pop culture machine," but not without their own unique transformations, through their own media-inspired, (pop) collective rainbow-fusions. In other words, while full of trash, pop, and low-fi dirt style, there is also something sincere and earnest to *Problem Solvers*. As Jacob Ciocci puts it in regards to the *Problem Solvers* characters, "there is still some magic in them. Some of that magic is precisely because they have been mutated so much."[72] Dirt style is here offered as a creative tool and technique for managing hyperdividuation in the post-industrial electronic age.

This homegrown media-culture affect applies to Paper Rad's work in general. Complementing their psychedelic, pizza-inspired cartoon, for instance, is the *Problem Solvers* web page, which features a preview clip for the work. The page contains multiple hypercolor composites on a turquoise background, including a four-color triple rainbow over which all of the *Problem Solvers* characters walk in an animated loop. Near the bottom part of the page is the *Problem Solvers* video clip. Once set to play, an upbeat electronic soundtrack begins (like those found in an arcade or video game from the 1980s) and an equally upbeat bald and red-bearded male narrator who identifies himself as "me" (the character's name is actually Dewey Petals) appears wearing a blue and purple patterned headband with a matching tank top covering his protruding, perfectly spherical belly. He explains[73]:

5.11 Paper Rad, *Problem Solvers* website, 2008. Bright graphics are animated using GIFs and saturated colors from the standardized web palette. Courtesy of Jacob and Jessica Ciocci.

> This is the *Problem Solvers*, and what that is, is a bunch of friends, me and my friends, and we go on cool adventures . . . there's Rivieria, he's our imaginary friend, but he's real, REALLY real; Tea Bubbles; Panda Monia, she's a witch; and D-O-G, that's our dog who is also magical and can talk; and Buck, a giant duck who doesn't talk, but he's cool; and uhh . . . "me," and we do our thing, but creatively, and that's our thing man . . . .

Paper Rad's characters also include "Tux Dog," the crime-fighting beagle inspired by Max Beckmann and Bill the Cat, who wears a top hat and makes an appearance at the end of *Problem Solvers* to serve the characters "Dog's Special." There is also Molly the Pony, a sort of "psychedelic reenvisioning of the My Little Pony toy brand." All of their characters invoke signifiers of the 1960s counterculture or children's television programming in the 1980s and 1990s, and their satirized, deadpan nostalgic return in collective mashups and chromatic remixes in the 2000s. In other words, the invocation of historical referents does not render a nostalgic mourning or melancholia, but instead a flat yet playful and composited hyperdividuation.

Other pertinent examples include *My Favorite Homepage, P-Unit Mixtape*, and the *Wizzardz* music video on the *Trash Talking / Taking out the Trash* DVD (Load Records, 2006) (figure 5.12), all of which use bright color composites juxtaposed with photographic elements to creatively satirize the more "serious" bling-bling colors in hip hop, the New Age, the 1960s, television, materialism, and 1990s cyberculture. *P-Unit Mixtape* (2005), a follow-up to *PjVidz #1*, for example, is a self-described mixed tape of appropriated and computer-generated elements mixed together in a delirious visual aesthetic. The protagonist is a short, sarcastic narrator whose body takes the shape of puffy blue cotton candy with stumpy limbs, a yellow snout, and thick black eyebrows. As he sits in the back of a limo wearing "ominous bling," he administers "absurd put-downs" to other artists and the art market to the "running soundtrack of the Wu-Tang Clan."[74] Midway through the piece, after a vintage clip of young men kicking one another into the back of a jeep, a spastic sequence of iconic and amateur cat-composites goes wild on screen, segueing into a series of children's songs abruptly cut by sounds of gun fire. As the colorful cartoon fantasy turns black—rendering the dangerous and violent conditions under which too many children attend school on a daily basis—the racism, misogyny, and ostentatious wealth flaunted by many hiphop stars today is both brought to bear and undermined as personified by a puffy blue marshmallow.

Another example is the introductory sequence to the DVD *Trash Talking / Taking out the Trash*, the point of which, according to Jacob Ciocci, is to say that "there is no menu on the DVD."[75] The sequence features the same blue narrator, first seen strolling down the street in a graffiti-strewn neighborhood to an arcade version of the Bee Gees song "Jive Talkin."[76] Once indoors, the narrator walks down a long hallway of differently colored doors with numbers

5.12

on them. He stops inside a room with walls covered in dripping spray paint and checkered patterns of fluorescent green, pink and yellow, with a giant clashing red “95” in the center to allude to computer and Internet technologies of that time. The music fades and the narrator, now lodged between an old computer processor and giant “A,” turns to the viewer stating: “Hi everybody, I bet you’re wondering where the menu is. In fact, some of you might be wondering if this is the menu.” Shifting into a moment of pseudo-Derridean metareflexivity, he continues: “but before you go using a menu, I think there are bigger issues at hand my friend. I mean, do you really know what a menu is?” He then shifts into an extended monologue about how “cool” CD-ROMs are to “click around” on, not to mention other early Internet technologies like “direct toast AGP-upgrades” and “e-walking.” When his lengthy but humorous rant eventually ceases (after three minutes), the *Trash Talking* movie begins.

In sum, as I argue in chapters 6 and 7, and of Paper Rad here, colorism in new media aesthetics in the 2000s speaks more to a cool and design-era indifference. This is a deadpan pseudo-objectivity that, while playful and sincere, is saturated with the commerciality of all forms of visual media and a newfound cynicism indigenous to the Internet age. It stands in stark contrast to the emotional, optimistic, and subjective aesthetics that characterized a majority of work from the midcentury avant-garde, aesthetic computing, and experimental media art discussed in chapters 1 through 4.

5.12 Paper Rad, Compilation of video stills: *clockwise from upper left:* (a and b) *My Favorite Homepage*, 2004; (c) *P-Unit*, 2005; (d) *Wizardzz* music video on *Trash Talking/Taking out the Trash*, 2006 (DVD Load Records). In dirt style, bold colors are juxtaposed and shapes intentionally overlapped and mismatched; a visual style made especially feasible with digital compositing. Courtesy of Jacob and Jessica Ciocci.

Dirt Style as Critique

Now that we have traversed the histories of compositing from blue screen through chromakey and the alpha channel and reached an understanding of the way in which spatial compositing has played a historical role in web aesthetics and twenty-first-century digital colorism, the questions can now be addressed: why bother to simulate dirt, bad technology, and crude color composites, when cleaner and more accurate options are available? And can these so-called amateur styles and indifferent interference aesthetics claim a stake in being progressive or political, simply because they are more fun and less smooth? The difference between the pixelated jaggies that made unwelcome appearances in the 1970s (and to some degree in the original dirt style net art from the 1990s) on the one hand, and the dirt style effects that appear exclusively for *stylistic* reasons on the other, is crucial.

In the history of the alpha channel, chromakey, and blue screen, rough edges and jaggies were at some point unavoidable, a testament to the *dys*functionality of the technology and special effects techniques used at the time. For example, in Campus's second sequence of *Three Transitions*, black mercury-like flakes begin to appear at the edges between composited layers. The more blue he paints on his face, the more black flakes appear. Chromakey compositing was not yet precise, automated, or, to use Bruce Sterling's term, "dead." Media become dead once they are fully functional, precise, and accurate and as a result, their possibilities for moving in new and unforeseen directions are closed off. The sophistication of the alpha channel in digital compositing marks analog-chromakey's deathbed.

One must then ask: as dirt style techniques are growing among younger generations of net artists and media makers, are concerns with critique growing alongside them? Note too that it is only *after* digital compositing is made precise and accurate, and clean styles became de rigueur in professional design, that net artists begin to develop these dirtier anti-styles. Is this second generation of dirt style then merely reactionary, invoking another surface style and series of eye-candy optical effects—a mimetic repetition without difference or criticality? And finally, recall that all digital imaging involves simulation at its most basic level. In other words, both digital dirt and the polished buttons of 2.0 employ the same algorithms and alpha channels to manipulate color in image space. Aren't both bodies of work therefore trapped within the same conditions of technological enframing—what Heidegger terms *Gestell*—and therefore determined by, and derivative of, the same cool and cold techno-rationalism? In closing this chapter, I want to offer three sets of claims that argue to the contrary.

First, by activating dead media in the form of less accurate graphics or conjuring up the colorful ghosts of TV and web design past—ghosts too quickly sacrificed on the altar of the slick, new, and easy to digest—Paper Rad undermines myths of linear progress and technological transparency pervasive in the

Internet industries, as well as the notion that newer, faster, and more efficient formats and styles are better, "cooler," and more attractive than older or slower ones. Instead of providing so-called transparent vehicles for the delivery of unobstructed "content," Paper Rad's graphics and offbeat humor block the flow of meaningful, or at least the production of, information. That is, their cool is like McLuhan's cool; cool as affect and aporia of information: "information designed to resist information," a paradoxical gesture through which an "ethos of the unknown" and the uncertain may struggle to arise in the midst of knowledge work.[77]

Second, in appropriating dead and obsolete media, Paper Rad's dirt style insists on bringing historical consciousness into each visible present. This occurs as one witnesses the use of outmoded techniques and forgotten web formats that, as they appear on screen, generate awareness of one's own material and technical viewing situation. In other words, by juxtaposing the old and new, Paper Rad is, precisely, offering a practical instantiation of the central tenets of media archaeology. Namely: to draw the failures, marginalized forms, and variants of a media's history into its present understanding and experience. In short, Paper Rad's images show us that aesthetic experience need not be driven by technological innovation or user convenience, and criticality—especially in regards to new media—can never be.

My third and last set of claims supporting Paper Rad's criticality concern color. It is obvious that their colors are in no way subtle or "pleasing to the eye," as is often sought in art and design conventions. Rather, their Warholian, ADHD-style remixes assault the optical nerves in a kind of sensory overload, performing a critical mimesis of the ceaseless flux and flow of 24/7 data streams in our information-intensive environment. Barbara Stafford's notion of "short form color" is useful here because it suggests a use of color that splinters and punctuates experience. Like fragmented Tweets arriving on your cell phone, short-form color consists of unexpected bursts of chromaticity appearing in rhythmical micro-pleasures dispersed through time and space. Their hyper-rapid and decontextualized nature both mirrors and engenders the new pace of hyperdividuation and desire in contemporary collective experience. Short-form color is not unlike Roland Barthes' concept of the *punctum*, or his theorization of color for that matter, both of which, he suggests, are erotic and aggressive; pushing out at you, destroying and disorienting coherent meaning just as they draw you back in, gesturing towards their own inarticulate sensual being. By interfering with and circumventing illusions of visual lucidity, digital transparency, and informatic smoothness, Paper Rad's striking colors make visible the "order and intensity by which sensations come to us" through our electronic screens, therein undermining normative habits of visual consumption and the often-unconscious routines that surround it.[78] And indeed, breaking with habit and cliché, as Deleuze and Guattari once argued, is one surefire way to open

thinking and experience to new possibilities and change. In this way, Paper Rad's highly affected color, as a primary example of dirt style, may very well present one of the necessary conditions for psychic and collective freedom and desire in the information age.

In sum, dirt style, in contrast to the slick and streamlined 2.0 look, forces a pause in media viewing practices, one that engenders a consideration of web design and new media on its most superficial and surface layer—as a series of hyperchromatic scintillations orchestrated through formal geometry—but also, the ways in which these luminous screens and surfaces are intimately and inextricably bound to the material history of aesthetics just as much as they are to the material history of computing and its progressive colonization of psychic and sensory life.

In the remaining chapters, my analysis of digital color grows much "darker" as I take this now functional and automated digital color palette, along with the concept of hyperdividuation introduced in this chapter, into a consideration of the ontological and epistemological consequences of an algorithmic lifeworld, analyzed in the next chapter through the framework of night vision and digital infrared. If digital methods like infrared visualizations have become vernacular, marked by discrete mathematical formulas and the logic of algorithms, then what does this entail not only for the production of visual knowledge (what I term "post-optics" or "algorithmic images"), but also for life and aesthetic experience in general?

3

“Transparent” Screens for Opaque Ontology (1984–2007)

Chapter Six
Digital Infrared as Algorithmic Lifeworld

> At the present moment, to assert the centrality or "hegemony" of vision . . . no longer has much value or significance.
>
> —Jonathan Crary, 1999

> So here we have an important revolution. Video images, infographic images, they are all images that speak . . . giving sight to a machine without a gaze, sight without seeing.
>
> —Paul Virilio, 2005

Midway through the last chapter I shifted gears from a historical analysis of color in aesthetic computing to a stylistic analysis, marking a transformation in moving image aesthetics from the manipulation of color *in time* to the functionalization and manipulation of color in *image-space*, which I extended to “cool” web design and dirt style new media art. In this chapter I push this a step further to argue that this automated digital color not only runs along a functionalized spatial register but also through ontological and epistemological registers characterized by an informatic and cool inscrutability. This coldness can be articulated as the visual attributes of low-fi and highly compressed computer graphics or a coldness that extends beyond the visible to what I have called the algorithmic lifeworld. In this chapter, algorithmic color in the form of digital infrared is analyzed as a system of control used to regulate bodies, realities, and experiences in an increasingly post-optic culture, using progressively pervasive and intrusive means. My analyses of the algorithmic image and lifeworld are conducted from material and aesthetic points of view, not technical or social scientific ones.

The chapter also takes an important lateral step *away* from the historical institutions and practices that I focused on in the previous chapters, moving instead into a murkier zone to explore broader theoretical questions about shifting political, epistemological, and ontological registers in the information society, the emerging relationships between the human and the machine, the visible and the invisible, and the knowable and the imagined. What does it mean to be posthuman and hyperdividual in an age of hyperintelligent machines? In adopting military technologies like infrared tracking and visualization systems in everyday life, what new configurations and transformations are demanded of us? In the world of hypertechnical algorithms and information processing, is humanity on the brink of yet another “decline” or “obsolescence,” as critical theorists are fond of arguing, or is there another kind of culture emerging, a kind of hyperdividuation (explored in the last chapter) with new costs and benefits that one must acknowledge through new analytic rubrics and without prior judgment? Do emergent forms of cultural expression—let’s say explicit YouTube exhibitionism or dirt style net art—necessarily preclude degradation, shame, or a lack of self-respect? If you think so, then which cultural values guide these judgments? While these questions detour from the concerns of the previous chapters, they will ultimately lead us back to digital color and its status in postindustrial media, art, and culture.

The chapter also builds on one of my central arguments about color: whether optical or algorithmic, *color is not exclusively about vision*. Rather, *it is a system of control used to manage and discipline perception and thus reality*. And perception, as I note in the introduction, necessarily involves a field of forces and strategies—power and knowledge relations—that extend beyond any single viewer, physical technology, or image-artifact. Color is part

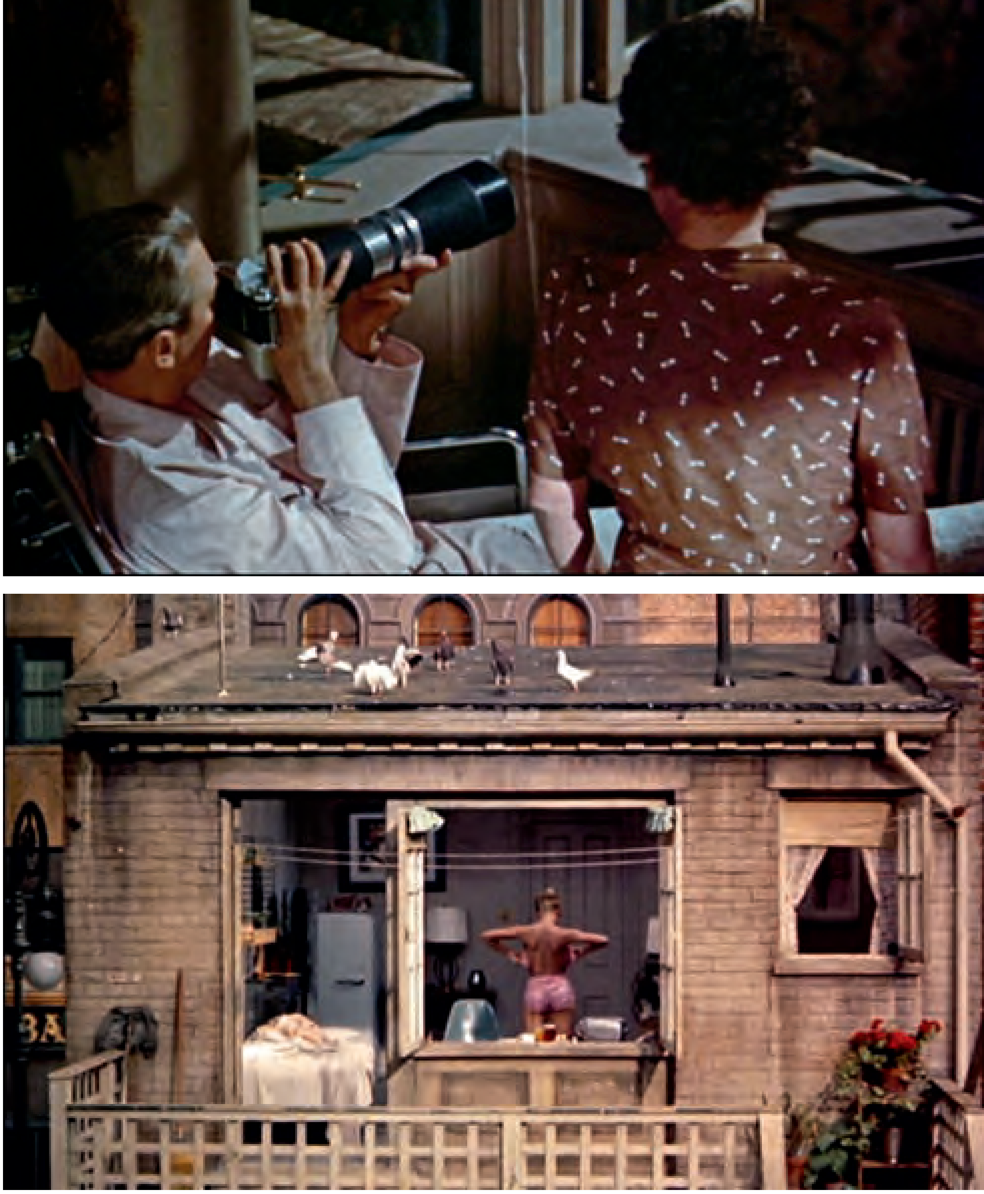
visible and part invisible and in order to see *how* we see, we must consider how these boundaries have shifted in recent decades and the ways in which these changes pose a threat to, and yet also serve as an extension of, models of vision that have been central to Western power, culture, and ideology for hundreds of years. Synthetic infrared, I demonstrate here, is the paradigmatic digital color for illustrating these shifts.

A Crisis in Vision

Put to the test in the information age is the classical figure of the voyeur alongside the entire visual episteme that bolsters it. Cinema's quintessential voyeur, the handicapped L. B. Jefferies (James Stewart) from Hitchcock's *Rear Window* (1954), was confined to his apartment and unable to walk or move quickly because of his elevated leg in a cast. Naturally Jefferies sat and gazed at his neighbors through his apartment's rear window (figure 6.1). Equipped with a prosthetic eye—his camera lens—he interpreted the minute visual clues that he saw, leading him to believe he had witnessed a murder, a suspicion that propels him and the narrative forward, resulting in a chaotic manhunt after which Jeffries' other leg was broken.

How would such a scenario unfold if Jeffries had been equipped with an infrared camera capable of tracking bodies *through* opaque walls and curtains? This question is key because it forces an unseemly comparison between two radically distinct modes of perception: the optical and the algorithmic. The former is rooted in the hegemony of the eye and the logos of vision, while the latter derives from post–World War II research in digital computing, cybernetics, and automated military weapons. As models, the optic and the algorithmic are metaphors, which means they are not hard-and-fast ways of dividing the world, but rather interpretive matrixes used to make sense of it, and in particular, of the emerging relationships between culture and information technology. I use four sets of concepts to highlight the distinctions and crossovers between the two models.

First, this crisis refers to the historical shift from the "disciplinary society" to the "society of control." The former, according to Michel Foucault, emerged in the eighteenth and nineteenth century and extends into the early twentieth century. It is characterized by a social and political infrastructure that deploys surveillance, optics, and *vision* to control and police bodies through discrete zones and spaces (*discipline* is a translation of Foucault's French term, *surveiller*). In the disciplinary episteme, a subject-effect is created through a series of mechanical yet fictitious relations: a subject believes he is being watched, even if he is not. This interpolation produces a psychological condition wherein the subject's behavior, in response to the *idea* of being watched, instantiates the disciplinary models' intended and implied forms of social control.[1]



Cast as an extension of, and in distinction to, the disciplinary model is Gilles Deleuze's 1990 theory of the "society of control." For Deleuze, the society of control emerged in the period following the Second World War and extends through the present. Characterized by the breakdown of discrete boundaries and the ongoing, continual processing of information, the technologies of the society of control emerge from postwar cybernetics and information systems and include codes, passwords, capture systems, and tracking technologies.[2] The distinction between these two regimes—the disciplinary and the control—is crucial because it points to a fundamental alteration from the use of *vision* and *optics* to the use of *information systems* and *algorithms* to control and manage bodies and behaviors. 6.1

6.1 Dir. Alfred Hitchcock, *Rear Window*, 1954. Film still. L. B. Jefferies (James Stewart) is confined to his apartment and unable to walk or move quickly because of his elevated leg in a cast. He sits and gazes at his neighbors through his apartment's rear window. *Bottom:* The view through Jefferies' rear window.

Second, the transition from the optic to the algorithmic is similar to information theorist Phil Agre's 1994 distinction between surveillance and capture as two models of privacy. The former, which is essentially Foucault's disciplinary model, is constructed through centralized means: central monitoring, central storage of data, and the dissemination of information through a central terminal. The surveillance model derives from historical antecedents in state surveillance, the planned-out malevolent aims of a political body, such as the "secret police," "Big Brother," and the Panopticon. The Panopticon is the paradigmatic example of the disciplinary episteme; an architectural model completely reliant on light and vision, often using glass architecture to emphasize this. Inside the Panopticon one is always bound to the eye and to the lines of sight that extend from it. The surveillance model involves nondisruptive, nonintrusive, or simply passive forms of data collection, epitomized by the immobile and passive voyeurism of James Stewart in *Rear Window*.[3]

In contrast, the capture model—generally analogous to what I am calling the algorithmic model—is indigenous to the information society and involves more intrusive, aggressive, and interactive means of data collection where human activities are systematically reorganized to *allow* computers to track them in real time.[4] It is important to recognize the ways in which the optic model emphasizes light, vision, and the eye but *deemphasizes* corporeality, a fact well noted by feminist film scholars like Anne Friedberg. Moreover, the deemphasis on corporeality is *inverted* in the algorithmic model where one cannot see, and yet the body becomes *the data and the target* needed to complete the feedback loop and (infrared) track. I will return to this shortly.

Third, the crisis in optical vision reflects an overall decline in the episteme inherited from the Enlightenment, where, to paraphrase Alex Galloway, the notion of seeing serves as a structure for knowledge acquisition, the undisputed clarity of reason, the logos of the eye, and the core pursuit of vision and optics in scientific research.[5] This is why Jonathan Crary in 1999 writes, to "assert the centrality or 'hegemony' of vision within twentieth-century modernity no longer has much value or significance."[6] Crary is describing the way in which *physiological* techniques for quantifying, managing, and controlling perception had been well under way by the mid-nineteenth century, as discussed in chapter 1, after which (visual) truth became an object of measurement, removed from the contextual lifeworld. Many have written on this topic, which I must leave aside, save to note Martin Jay, who in 1994 also analyzed the demise and denigration of the primacy of optical vision in nineteenth-century France, which he linked to the rise of poststructuralism in the twentieth century.[7]

This visual episteme is also the one that Heidegger critiqued in the "age of the world picture," an epoch where one knows and experiences the world indirectly, by picturing it. As he puts it, the "world picture, when understood

essentially, does not mean a picture of the world but the world conceived and grasped *as picture*. What is, in its entirety, is now taken in such a way that it first is in being and only is in being to the extent that it is set up by man, who represents and sets forth."[8] In other words, the modern world is only known by man by picturing it in advance of actually "seeing" it, phenomenologically.

For Heidegger, however, this conditions an ontological opacity and technological enframing (*Gestell*) that began well before the Enlightenment, with the Greeks and the origins of metaphysics (as discussed in the introduction). It is in this broader sense that the algorithmic model can *also* be positioned as *an extension and intensification of the optical regime* and its corresponding narrowing of truth and phenomenological experience. In other words, optical vision is also always already subject to technical enframing, calculation, and math—as is the algorithmic model—and this should not be forgotten.[9]

The primary goal in this chapter is to temporarily put aside this broader genealogy in order to use color (digital infrared) to emphasize the mathematical intensification and transformation of perception in the *age of algorithmic optimization*. Therefore, while I primarily stress the *distinctions* between the optic and the algorithmic throughout the chapter, it is nonetheless valuable to recall this larger history and third genealogical concept, where, to repeat, the visual and optical regimes are both deeply enframed, preprogrammed, and calculated. Throughout the chapter I use the term "optical vision" or "optical image" to denote the first episteme, or any image rendered or perceived through a human eye, with or without a visual prosthetic. And by "visual" prosthetic I do not mean informatic or computational prosthetics. As I have noted throughout this book, and especially in chapter 2, digital video and computer media are *not* primarily visual media, rather they are information technologies that rely on electronic signal processing to generate image-effects.

A fourth way to understand the imbrication of the optic and algorithmic is to note that a paradigm shift is not the same thing as obsolescence. To the contrary, optical methods and technologies coexist alongside and within the algorithmic paradigm. For instance, many infrared images exist as data visualizations, which are the output of algorithmic procedures. These images, entirely generated and fabricated through mathematics, nonetheless support and bolster the primacy of visual evidence. The relationship between cultural dominants and residuals are, as Raymond Williams has noted, continually shifting and thus residual values often persist within the dominant culture.[10] In other words, to propose that one can clearly distinguish between the two is in many ways to oversimplify the complexity of modern perception as a system of management and control. And yet, in order to reflect on and theorize the *particularity* of the ontological and epistemological shifts in the contemporary historical moment, in this chapter I have formally distinguished them.

The Algorithm

Given the ubiquity of simulated and digitally generated images, which rely on algorithms, one must ask, What counts as "visual knowledge"—i.e., power and truth—and who or what, more appropriately, creates, circulates, and legitimates it? For some the answer is obvious: computers analyze and process cultural data using sophisticated and highly efficient algorithms that exceed human capacities. But for others this thesis triggers acute fear and negativity. If we can't see or understand these highly automated, inscrutable systems, then the kinds of dangers they could bring about become equally unfathomable and therein magnified. Fair enough. Consider too that informatics and algorithms may have become so pervasive and naturalized in everyday life that these machines and their governing logics have become equally invisible and impossible to identify. Computers and algorithmic systems are progressively given authority over human action and experience, and while this occurs ultimately by way of human *choice*, within only a few degrees of abstraction and automation, we have a dwindling capacity to recognize this.

At the heart of these automated computational processes is the algorithm: a well-defined set of steps and encoded procedures used to transform data and execute an operation, often with the imperative of optimization.[11] If you want to turn a digital image monochrome red, you need to apply a red filter from the effects menu in Photoshop. But as far as the filter or operating system are concerned, this is simply a set of algorithms run through a larger data set to alter the image's code and then re-render "red" onscreen. The algorithms have no idea what "red" actually looks like. In fact, if any so-called image exists in a computer system, it is always and only, as I argued in chapters 2, 3, and 5, the *result of nonvisual, algorithmic processes*.

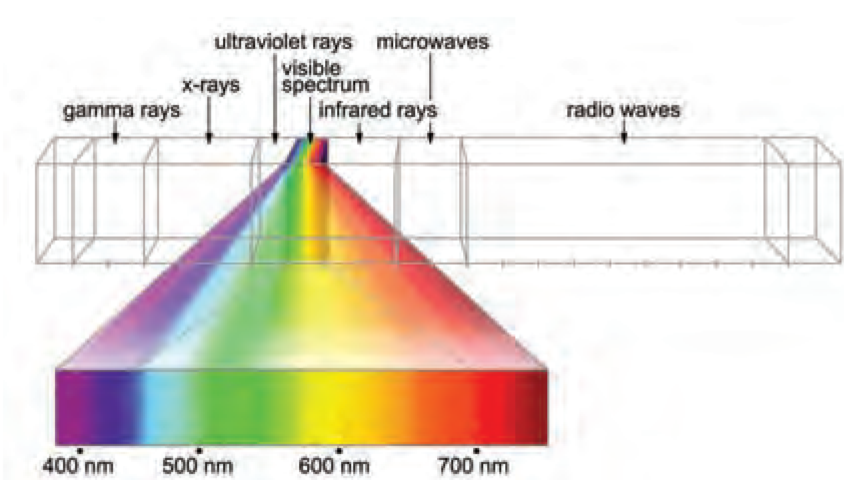
Algorithms structure the conditions of possibility for a video game, software, or interface, and these parameters have nothing to do with optics or vision, at least not at first. Algorithms need not be electronic or found in a software application, but they are always computational, statistically oriented, nonspontaneous, numeric, and formulaic.[12] For instance, one could be faced with an arithmetic problem that can be solved *only* using a unique proof or equation. There is no way around the steps, they must all be taken and they must be taken in a set order. Insofar as they form the basis of all modern computing, algorithms engender an ontology and epistemology rooted in informatics. They are used to rank, sort, and monitor user activity, as well as to legitimate information on almost all websites and search engines. Some of the most common examples include Google, Facebook, Twitter, or Equifax, a U.S.-based consumer credit reporting agency that leverages complex algorithms to extract value from databases.[13] In turn, these hubs, data centers, processing units, and web sites disseminate knowledge using techniques that are shaping culture in profound and intense ways. The algorithm has become "a key logic governing the

flows of information," Tarleton Gillespie argues, enabling and assigning meaning to what, how, and when information—which is to say knowledge—is consumed, learned, and perceived.[14] The algorithm forms the backbone of the new synthetic lifeworld, determining the horizon, or "distribution of the sensible," as Jacques Rancière calls it, for what *can* be visible, invisible, and audible, as well as what can be said, thought, made, or done.[15] Moreover, this all occurs a priori, *before* perception or experience occurs.

Because operational algorithms bear a markedly nonvisible mathematical nature, the ways in which the sensible and perceptible intersect with technical media have become that much harder to detect and grasp. This is another reason why I have chosen to focus on algorithmic *images*, because through these visualizations, articulations of fear, denial, and anxiety surrounding the new distribution of the sensible become resolute. After explaining what digital infrared is and why I use it for my analysis of algorithmic images, I then outline three interrelated and often overlapping tenets that I use to classify algorithmic images: informatic data reduction, predicative scanning, and the allegorical presentation of data, illustrated through key examples in cinema and media art.

Infrared

Infrared is a form of long-wave electromagnetic heat radiation comprised of near, mid, and far ranging waves that together fall between 700 nanometers (nm) and 1 mm (where visible light falls between 400 nm and 750 nm) (figure 6.2).[16] Infrared is therefore almost entirely invisible to humans, so "seeing" it depends on synthetic processes from capture to screen display. While infrared is naturally invisible to humans, it is visible to some animal species like rattlesnakes and bats (ultraviolet light is also invisible to humans, but not to bees, who use it to guide them during pollination).



6.2

6.2 Visible light falls between 390 nm and 750 nm while infrared falls just beyond the red end, between 700 nm and 1 mm, making it largely invisible to humans.

If infrared *cannot* be seen by humans without the aid of machines then some may ask, can it be considered a color at all? According to anthropology or humanist philosophies, it cannot. But as far as machine-generated color is concerned, what counts is the fact that through technology color is *made* to appear; it is forced out of its "shell" by way of rational calculation, as Heidegger puts it. Both ultraviolet and infrared are synthetic colors whose very existence foregrounds the centrality of machines and information systems in modern perception. In order to analyze infrared, it is therefore necessary to wrest traditional notions of color from anthropocentric theories of vision. Moreover, the status of digital infrared as synthetic is here underlined in order to indicate how it, unlike other industrially produced synthetic colors (like indigo or fuchsia), cannot conceal the artifice of its production behind a naturalized veil of cultural or ethnic authenticity.

Ultimately one could use any real-time digital image to illustrate the aesthetic logic of algorithmic images. However, for several reasons I chose infrared, and specifically *digital infrared* (when I refer to infrared hereafter its status as digital is implicit, unless otherwise noted). The first reason is that the development of infrared is intimately bound to the history of the military industrial complex and the advancement of modern automated weapon systems in the postwar period. Especially attractive to weapons developers is the way in which infrared, unlike naturally visible color, is adept at penetrating long distances, opaque objects, and surfaces. (However, while visible colors can penetrate glass, infrared cannot—strangely, the one material that optical devices use to amplify and clarify perception is the same one that blocks infrared.) In short, infrared has become a prime tool in the development of distance-based tracking and targeting technologies and as such, a signifier of militarized perception, codified by a cold low-res green (green being the color that most effectively depicts value differences between light and dark, or black and white).

Second, any visualization of infrared invokes shifts between the visible and the invisible and the digital transcoding process where one source, here heat energy, is captured and translated into another language or system (code), which is in turn used to generate light-based images called "heat maps." Translating code into a visual form is not the same thing as copying an image (mimesis) or the re-presentation of data, but instead involves a process of *simulation* from one register to another. I have been hinting at this distinction in the previous chapters and I will return to it in my discussion of the allegorical presentation of data.

Transcoding is specific to digital media and therefore it is not necessary with analog infrared.[17] The rudimentary analog infrared weapons employed and developed as a form of night vision during World War II, for example, were relatively weak and often dependent on available visible light. This is because, as analog media, the weapons have a *direct* and *continuous* relationship be-

tween their input and output points, as with the video signal processing experiments discussed in chapter 2. In contrast, the digital infrared weapons that emerged at the end of the Cold War in 1989 were highly automated, a part of the increasingly sophisticated military weapons arsenal that consists of "stealth" weapons and the ever-popular "fire-and-forget" smart missiles, which allow a pilot to use infrared detection systems to scan and lock on a simulated target and then set a missile to automatically guide itself to the target, even if the target remains in motion. Here infrared becomes so automated that neither pilot nor system needs to "see" beyond the initial target lock. By the end of the 1980s, automated infrared missiles obtained yet another degree of accuracy in detection and execution, first put to use en masse during the first Gulf War in 1991, in which, according to the military, they yielded "spectacular" results, evidenced by the fact that the Iraqi air defense system was "destroyed in the opening minutes of conflict."[18]

As a testament to the way in which these automated military industrial technologies have been naturalized in everyday life and culture, one need only consider the growing number of infrared systems adopted in commercial, business, and entertainment industries. Infrared is also common in consumer products, including the blinking red light on a computer mouse, remote control, Xbox console, or Microsoft's Kinect, an infrared tracking software for game play. And while it is less common, infrared is also used to manage and control labor and workflow. At the Olivetti company, an Italian manufacturer of computers and printers (the company also produced the first desktop computer in 1965, known as the P101),[19] employees wear what is called an "active badge"—a black plastic rectangle on their clothing from which strategically installed infrared sensors can read where the workers are in relation to the equipment and walls.[20]

Consumers have also learned to use infrared to build weapons. Insurgent groups in Iraq and Afghanistan have transformed simple consumer products such as keyless entry fobs and garage-door openers into devices to trigger improvised explosive devices (IEDs) that have been used to kill and maim U.S. soldiers. More recently, the Chinese employed infrared-based consumer products to develop a laser weapon used to shoot down a satellite.[21] The military has in turn been influenced by these homegrown civilian weapons and has reintegrated some of the techniques back into their own weapons arsenal.

Tenets of the Algorithmic Image

If the logic of an algorithmic image is not contingent on traditional visual registers but instead on a kind of (blind or automated) programming, then how does one approach it or understand it? I analyze infrared images using the three *interrelated* tenets of informatic data reduction, predicative scanning, and the allegorical presentation of data. In this section I address these tenets

through examples from art and cinema and by contrasting and clarifying how infrared, as an algorithmic image, is distinct from a traditional optical image. Again, for the purposes of analysis, the tenets are distinguished though ultimately they overlap and work together in practice.

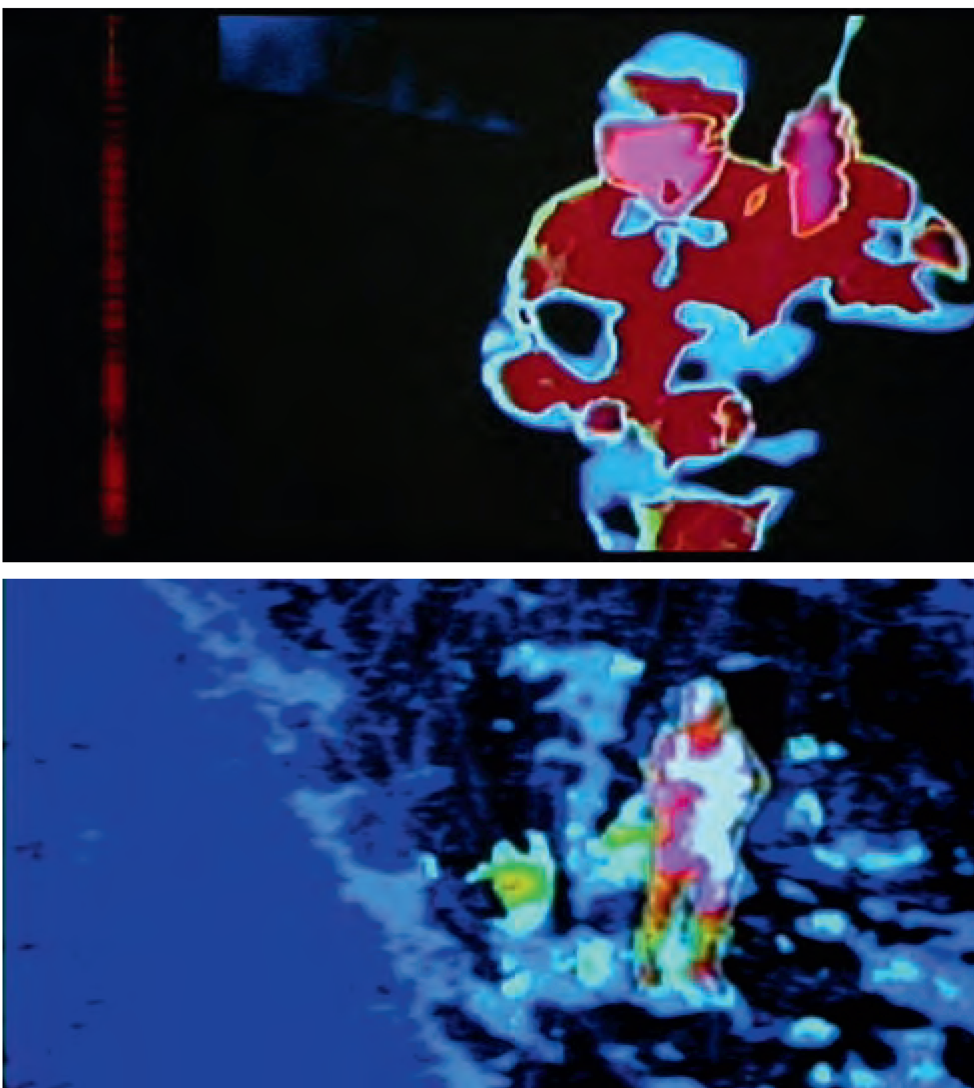
1. Informatic Data Reduction

The informaticization of data is ultimately what makes an algorithmic image *statistical* in nature, like any chart, graph, or scientific data visualization. At the core of these information visualizations is a radical reduction of what *appears* to be superfluous information. The law of information processing maintains that the fewer states one needs to process a message, the faster and more efficient the system is. This logic of optimization is indigenous to data visualization systems and, as Lev Manovich points out, its roots extend through various practices in Western science including nineteenth-century physics, biology, linguistics, statistics, economics, and psychology, fields that have all attempted to represent the world, or some aspect of it, in the simplest possible terms, whether in elements, atoms, parts of the mind, or the Weber-Fechner law of just noticeable difference.[22] Phil Agre has argued that this kind of statistical reduction can be understood in terms of "grammars of action." Like an algorithm, each grammar is defined as a "set of standard moves" that can be compiled or encoded into one grammatical unit,[23] such as the total set of moves one needs to undertake in order to get through an entrance or exit on a freeway system. In constructing a grammar, a necessary black box effect occurs wherein a set of real-world affairs, often with continuous and contradictory bits of information, are boiled down into one state, or set of states, that then serves as representative of that activity.

Numerous artworks and U.S. military and action-genre films produced in the last few decades use infrared to express rampant fears and anxieties surrounding this radical reduction of information that lies at the heart of the algorithmic image.[24] For example, in the opening scene of David O. Russell's *Three Kings* (1999) questions arise concerning the loss of human vision and the limits of infrared perception. Three U.S. military pilots (played by George Clooney, Mark Wahlberg, and Ice Cube) have just finished a tour during the war in Iraq. The war is presumably over and the three are driving back to base through the desert in a Humvee. Wahlberg and Ice Cube begin shooting footballs out the back of the truck, complaining they "didn't get to see any action in the war." Clooney promptly stops the vehicle, pulls them out and shows them a grey corpse, hollowed and rotting on the ground. The two are viscerally disgusted. They see what they could not have seen from the sky in Apache helicopters, wearing night-vision helmets, or on the ground using stealth weapons. The film highlights precisely how war is no longer fought in the visual realm. As Russian Admiral Sergei Gorshkov famously predicted in 1956: "The winner of the next

war will be the side who made the most of the electromagnetic spectrum."[25]

Hyperbolic fears surrounding the radical compression of data and its resultant invisibility are also epitomized in John McTiernan's *Predator* (1987). When a combat team is dropped into a thick jungle region on a mission to rescue a fellow officer, a strange presence in the jungle (the Predator) soon diverts the men's attention. They begin to focus on this invisible force that they cannot see, smell, or touch, but which nonetheless tracks them through infrared detection (figure 6.3). The Predator is portrayed to hold a significant hunter-prey advantage over the men, not only because he is invisible to them, but also because he can see in ways that are exclusive to, and exceed the limits of, human perception, with or without the aid of an optical prosthetic.



6.3

6.3 Dir. John McTiernan, *Predator*, 1987. Film still. A combat team is dropped into a thick jungle region where the Predator, whom they cannot see, smell, or touch, begins to track them through infrared detection.

In the film, the Predator's subjective perception is represented by "heat images" that appear onscreen in a grid overlay with a vertical "levels" bar on the left, and at times, with crosshairs over the center of the heat image, hovering over the human target. Throughout the film these algorithmic images are juxtaposed with optical images from the film camera. The filmed images appear from a human's vantage point where one sees green trees, flesh tones, depth of field, and perspective, by way of the camera's emulation of optical realism and stereoscopic vision. In the film, depth of field and perspective are aligned with the optic regime, which is imbued with an almost Edenic, utopian quality (which is also to say naturalized and seemingly ahistorical and nontechnical). In contrast, the informatic heat images are linked to statistical abstraction and automated machine efficiency. The Predator will function regardless of surrounding, decontextualized from any meaning or lifeworld other than what the Predator's tracking algorithms have been programmed to execute. As shots cut back and forth between the two perceptual systems, they antagonize each other, as if wholly distinct and unrelated. The portrayal of this separation only intensifies the anxiety surrounding the obsolescence of traditional vision, contributing to a historical amnesia that allows newer machine systems to appear separate and distinct from humans and what is already a highly mediated human experience. Those who oppose technics to civilization, as I argue in the introduction, are also those who cannot or do not accept that humans are always already prosthetic beings. As Stiegler puts it, "humanity and technics are indissociable."[26]

Two other noteworthy examples of this hysteria in the discord between humans and machines—from the 1970s—are Michael Crichton's 1973 *Westworld* and Dennis Oppenheim's *Aging* (1974). In the former, a group of tourists outfit in retro–Wild West fashion visit a computer-automated playworld but the infrared-equipped robots that inhabit Westworld grow restless and out of control. Using their infrared tracking systems (represented by patches of thick red paint) they turn on the visitors with the goal of capturing and destroying them. Fear arises as humans (both in and outside the film) find themselves with a dwindling capacity to control this flow of highly redacted information fueling the robots.

One year later, Dennis Oppenheim produced *Aging*, an installation that consists of a row of infrared lamps in front of a row of wax figures that slowly and imperceptibly melt over time. *Aging* plays on fears associated with infrared radiation, a violence done "to" man and made to seem all the more potent precisely because it cannot be seen. At the center of the piece is the "theme of the homunculus or automaton," Thomas McEvilley writes, "the idea that human beings are like stamped-out mechanical entities lacking free will."[27] Such a statement, again, taps into ahistorical and naïve notions of technological determination that arise through a lack of understanding surrounding information

processing and the specific kinds of enginering involved in data reduction and compression in infrared systems. In this way, the statistical reduction of infrared *is* its invisibility.

In the U.S. in 1970s and 1980s, the growing fears and anxieties surrounding the then-new strategic defense initiatives (dubbed “Star Wars” due to its utterly alien and seemingly sci-fi nature) only reinforced the false antagonisms between humans and machines, especially given that one of the primary purposes of the military defense system *is* to kill human beings. But of course there are always humans involved, from the ones pulling the trigger and flipping the kill switch, to those programming and engineering the back-end system. The use and representation of new technologies to further misperceptions that machine processing is separate from the intangible yet intimate dreams, desires, and choices that shape them only heighten mass fear, panic, and anxiety.

One final example of fear surrounding the informatic reduction of data is selected from Phillip Noyce’s *Patriot Games* (1992). In one charged scene, the CIA uses satellites with infrared capacities to gather intelligence for an attack on Camp 18 in North Africa (figure 6.4). The satellite images and guesswork lead the CIA to believe it has found its targets, members of an ultraviolent faction of the IRA. They make a decision to bomb the camp. The officers gather in the control room to watch the attack through infrared satellite images. Pleased with their kill, which they see onscreen, they only discover later that they did not in fact kill the target they thought they had. Their decision to execute is based on a hazy image that they interpret as the correct target. Absent from the image are attributes of nuance and detail, those very qualities that have allowed optical imaging technologies like film and photography to be inextricably bound to truth, indexicality, and “objectivity.”

6.4

6.4 Dir. Phillip Noyce, *Patriot Games*, 1992. Film still. The CIA use their globally positioned satellites and infrared imaging to unnecessarily attack Camp 18 in North Africa.

A problem arises then when infrared images are treated in the same way as optical images are: one forgets that a *fundamental reduction and translation* between languages and coding systems has occurred. Recall from the introduction and chapter 3 that in information theory and cybernetics, semiotic and cultural meanings are "bracketed" out in favor of analyzing algorithmic processes and thus the resultant image *cannot* be approached or analyzed in the same way as optical images can. The same applies to data visualizations where one must be absolutely clear about the context, criteria, and parameters of the algorithms and algorithmic systems written and used to capture and render the data; without such acute awareness, "big data" visualizations become arbitrary and meaningless.

2. Predicative Scanning

Infrared systems are completely nonspontaneous, but they can see into the future. This is known as predictive scanning, a high level of automation and executability, which involves using preprogrammed algorithms and data from the past to "see" or track data in the present and the future. It is highly flexible and dynamic and, when coupled with feedback, allows a system to act "intelligently," which to some extent it is, because it *can* see the future, within a degree of probability. This is why the Predator's "prey" have been "caught" long before it ever "sees" them in the jungle: a prey's heat signature has been programmed into the system prior to contact. Phenomenologically, the algorithm never sees in the present, only the past and the future.

The Predator "sees" and tracks his prey by re-cognizing their heat signatures and upon a match, executes another set of preprogrammed operations. In the film this involves using a preprogrammed analysis of data to kill a target but in everyday life, precisely the same kind of predictive data analysis amounts to more banal activities like determining which books to recommend to you on your Amazon homepage, or which friends Facebook will suggest for you on your next visit. These suggestions are determined based on your earlier patterns of use, and yet their governing logic appears opaque and inscrutable. So while algorithms are smart, their intelligence in predicative scanning derives only from the way in which they reduce and then extrapolate complex human activities. To put it differently, "seeing" in infrared is really a form of data analysis that cannot actually see or act spontaneously in relation to events, despite giving appearances to the contrary.

For example, in *Zerseher* (1991–92) by German new media artists Joachim Sauter and Dirk Lüsebrink (ART + COM), a gallery visitor finds a framed picture hanging on the wall, but upon coming closer to the canvas and looking at the image, the viewer notices that the exact spot on the picture that she is looking at is changing under her gaze.[28] To create the piece the artists set up an infrared system behind the wall to track the visitor's eye movements.

The viewer observes the picture, while the picture tracks the viewer. The captured retinal data is then translated into a corresponding set of changes in the digital painting that the viewer sees on the wall in front of her. The viewer, a user really, “creates” the image through eye movements, the result of indirect data exchange.

Once the user realizes that she has been unknowingly implicated in a closed feedback loop, she has the choice to leave, or to stay and play the game: intentionally altering the painting by moving one’s eyes in a desired direction. But the point of the work is to catch and implicate the viewer in the work, before she has realized her involvement. By reversing traditional power dynamics between the “genius” artist and the “passive” viewer, *Zerseher* instead explores the ways in which information exchange creates a new logic in machine-generated art and interactivity that, like the control society, is not necessarily contingent on consent or intentionality, but on preprogrammed conditions, behaviors, and a priori protocols.

Similarly, in *Eye Drawings* (1992–93) German new media artist Joachim Hendricks appropriates infrared-embedded helmets used in Baghdad in 1991 to capture a user’s retinal movements. The captured data is processed by a computer, which in turn generates a drawing based on where the wearer’s eyes moved. However, unlike the Apache helicopters and the pilots who wore these helmets during the war, in *Eye Drawings* the user can adjust his or her eye movement to effectively manipulate the system. This is often not the case with military uses of the Apache helmets, especially with more recent models where pilots do not have the ability to adjust the helicopter’s direction, even though their retinal movements are being captured by the navigation system and used to determine flight paths in real time.[29] The piece underscores the way in which optics and “seeing” are no longer ends in themselves but instead a mere means (a source of data) to another, predetermined end. In infrared systems, power and the traditional (though naturalized) link between vision and agency is severed. These systems “see” and track the movements of a user’s retina by compiling and interpreting data from the past and projecting it into the future, but the retina itself does not “see” in any way that is contextually or epistemologically powerful.

This points to one of the primary limits of predictive scanning, which also lends itself to another source of fear. Infrared images *only* allow a system to “see” within preset parameters. Anything that comes into view that has not been programmed or given a specific corresponding algorithm (for example, an unknown target or a similar heat signature) will result in failure, breakdown, misfire, misrecognition, or it will simply be invisible to the system. In short, if predictive scanning is the basic mode of re-cognition in infrared imaging, which is to say the conditions of possibility for perception, then any image that results can only be an iteration of these preselected and predetermined laws.

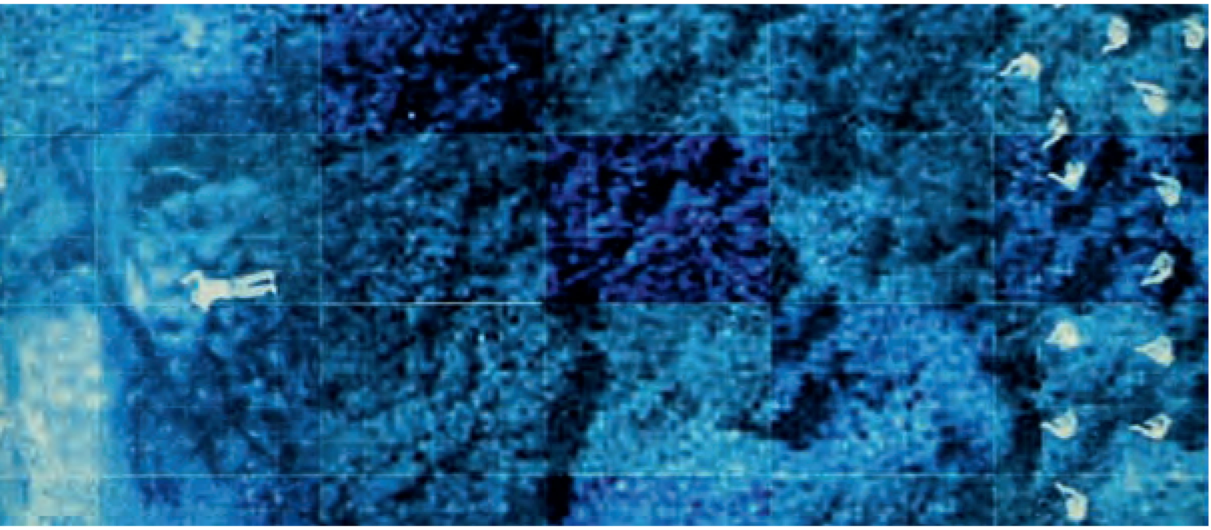
3. The Allegorical Presentation of Data

If chromakey compositing, as I argued in the last chapter, marks the functionalization of color in electronic signal processing, then infrared is the next step in this process. With the algorithmic image, there is no visual representation or image until the preprogrammed system has tracked, caught, and processed the data. Color is produced only after the fact, as an addendum to what has already occurred. In this way the so-called image is congruent and allegorical, but not indexical. The allegorical presentation of data demonstrates how the status of the image has been destabilized, now existing as an unremarked adjunct to the algorithm.[30]

In other words, the allegorical presentation of data ensures that any algorithmic image is disconnected from the so-called natural conditions of vision. That is to say, an algorithmic image is always simulated. For example, infrared is often presented in the form of a thermal map in which the color palette usually consists of four or five opaque spectral hues, arranged in concentric circles from the hottest to the coolest. These colors are of course arbitrary and indexed.[31] Red usually denotes the hottest area, while blue indicates the coolest (in sophisticated thermal imaging the coldest areas are black and the warmest are white.) A thermal image of a human body would be black or red at the center, gradually shifting to orange, to yellow, and to green at the edges. These thick patches of opaque colors resemble nothing like the subtle gradations between different tones or hues, as illustrated in a typical photographic image.[32] Infrared systems use heat data to simulate a "real" world event or affair, just as an allegory in literature simulates another narrative or a historical event. But note that this allegorical status also means that infrared images bear no *direct or essential* relation to the event or object they ostensibly depict. What is registered in a live infrared image is a set of changes *between* states, a drama occurring within the system's elements and not the empirical or physical entity it simulates.

An early scene from director John Moore's *Behind Enemy Lines* (2001) illustrates this principle. Protagonist Chris Burnett (played by Owen Wilson) is a US Navy flight lieutenant whose plane crashes behind enemy lines in Bosnia during the war in 1995, his partner killed during the crash. His fellow officers at the U.S. naval base, while able to locate him on the hi-tech GPS satellite through sophisticated infrared tracking, remain powerless to do anything to help him beyond watching images of his silhouette on the screen.

Burnett runs from the Bosnian-Serb soldiers who are pursuing him. After gaining a slight lead, he suddenly stops and falls to the ground. Through the satellite images, his Navy colleagues see the enemy approach, stand, look at him for a moment, and then turn around and leave. Those watching from the base conclude that he has been shot dead (figure 6.5). But because the American officers are unable to fully "see," what they think they saw was not what



actually happened. This is revealed to movie viewers a moment later when Burnett stands up and begins running again. Burnett had concealed himself by lying in a swampy puddle of dead Bosniak bodies to camouflage himself from the rapidly approaching enemy. When the Bosnian-Serbs reach him, they recognize the pile of cadavers as those they executed in this location just weeks prior (indicated by flashbacks). The Bosnian-Serbs poke around in the mud pile, don't see anything moving, so they leave. No one—neither humans nor infrared machines—sees the "truth" of the situation, and yet everyone sees "correctly." Humans see optically and machines see allegorically. 6.5

Another way to articulate this distinction is summed up by Rosalind Krauss in her recent summation of Charles Pierce's classification of the index and the iconic. In film and photographic images, seeing *is* light; the image is an actual artifact indexed and sampled from "the world," chemically altered for representation in the image. These are *indexical* media forms, Krauss explains, because "a trace is causally registered on film (much in the way fingerprints or footprints are left at the scene of a crime)." In the photograph or film, there is a literal sample of light in the image. In contrast, "painted images are . . . *iconic* because the relation they have to their referents is not causal but contrived." The iconic also applies, she continues, "to the digital image, mark[ing] out its difference from the indexicality of photographs and celluloid film."[33] The iconic image breaks with the indexical image's causal link between world event and image-artifact. This distinction is an important one and it works in tandem with my distinction between optic and algorithmic images.[34]

At the same time, the *distinction* between a digital image and a painted image is precisely what qualifies the former as a "technical image" and the latter as a "traditional image" for Czech-born philosopher Vilém Flusser. Technical

6.5 Dir. John Moore, *Behind Enemy Lines*, 2001. The human interpretation of this infrared satellite feed leads military officials to conclude their officer has been shot dead.

images, Flusser argues, are *concepts* made into visualizations, just as an algorithmic image consists of a set of algorithms executed to produce a visual result. A technical image is a "mosaic assembled from particles."[35] Raw data particles are captured, sorted, and ordered through optimization systems and informatization, after which their tendency towards entropy (the second law of thermodynamics) is decreased, if not reversed, so that a new and enforced "negative entropy" in-forms the "particles" to allow them to concretize into some sort of "visualized" pattern or order. Technical images are a priori abstractions only *later* made concrete. They are distinguished from "traditional images," which are used to grasp or "depict" the world and the environment through "magical" actions, which are then translated onto a surface. This may also be understood as mimesis or re-presentation. In contrast, technical images derive from science and information processing, the basis of which is "not images at all but rather symptoms of chemical or electronic processes."[36] That is, the result of a particular configuration of particles or algorithms, run according to specific rubrics, which *end up* in visual form, as an effect.

The difference between the optical image and the algorithmic image is analogous to Flusser's distinction between the traditional and the technical image. The technical image, which is to say the algorithmic image, "transcodes symptoms" (data captured form the world) using the programs and rubrics of cybernetics and information theory. The technical image is also a precondition for what Flusser terms "post-historical," a condition indigenous to media culture and characteristic of the Photoshop cinema, as discussed in the next chapter.

Both technical and algorithmic images are also post-hermeneutic.[37] They no longer provide "explanations" nor can they elucidate or give meaning to humans in the way that a traditional photographic image lends itself to a photo-realistic conflation of truth and reality. For example, a snapshot of a man standing in front of the Eiffel Tower suggests certain semiotic facts and cultural conditions of the situation in a way that an infrared visualization of this scene could not (precisely what is missing in the allegorical presentation of Burnett's body, which only registers as a shift from its vertical to horizontal position). Technical images "capture meaningless signs" that, as I have argued above, *cannot* be grasped or interpreted in the way that traditional images can, by way of hermeneutics. Rather, *what* a technical image means is *how* it is structured—i.e., the protocols that condition and predict its possibilities for existing, as such. "To decode a technical image," Flusser explains, "is not to decode what it shows but to read how it is programmed . . . The semantic and pragmatic dimensions of [a] technical image are identical."[38]

And while Flusser accepts media like film and photography into his category of technical images (even a typewriter counts), I distinguish algorithmic images from traditional optic images and typewritten pages, due to the severe degree of abstraction, logistical engineering, and optimization imperatives at

the heart of algorithmically derived images. In fact, as Flusser's thinking developed, he drew distinctions between electronic and chemical images. Information images were "purer" forms of technical images, he argued, because they had a greater tendency to organize information through mathematics, discrete calculation, and statistical processing. After the "Information Revolution," he wrote in 1984, "contemporary films [will] resemble the cave paintings at Lascaux more closely than they do images of fractal equations of computer screens." That is, the distinction between informatically generated images and traditional optic images would grow wider.[39]

In sum, the allegorical tenet of infrared imaging necessarily involves a process of simulation that problematizes semantic, hermeneutic, or semiotic interpretation. This is also why I have used the word "presentation" of data and not "re-presentation," which would imply a mimetic movement from origin to copy, as with a photograph or film frame. This allegorical dimension is also what allows algorithmic visualizations to be compared both with Krauss's and Peirce's distinction between the indexical and the iconic, and with Flusser's technical image. While algorithms can be used to obtain a degree of automation and in specific cases be of tremendous power, the economic logic of data reduction, the allegorical presentation of data, and the tenets of predictive scanning that define infrared visualizations bring with it new sets of problems that, if overlooked, could result in serious "real world" problems. These are precisely the fears played out in films like *Westworld*, *Predator*, or *Patriot Games*.

The Algorithmic Lifeworld

That algorithms and algorithmic images are today constitutive of the lifeworld is both provocation and thesis. On the one hand, the logic of economic efficiency and cost reduction, as exemplified by the algorithm and discussed above, is increasingly dominant in postindustrial late-capitalist society. In this way, my arguments for the algorithmic production of vision and post-optics may be seen in distinction to traditional models of vision and visual epistemology exemplified by *Rear Window* or the Panopticon. On the other hand, as I argue above and in the book's introduction, mathematics and calculation have from the start been fundamental not only to culture but also to our very notion of what it means to be human. In this way existence is always already technical, mathematical, and calculated, and so too is our "consciousness," to use Stiegler's terminology. We are inscribed *through and within* technics, from logos to infrared, and therefore both technics and being are always part psychic, part social, and always historical. Technics are also always aesthetic, or rather, aesthetics form along a front through which technics are adopted and legitimated into everyday life and culture. For example, consider this account which I borrow from Fred Turner, in which infrared, formerly in the exclusive domain of military

tracking, becomes aesthetically legitimated and culturally acceptable.

On October 14, 1966, approximately 1500 audience members comprising highly influential New York society figures and politicians, including New York's Senator Jacob Javits, assembled at Manhattan's 69th Regiment Armory to witness one segment of Experiments in Art and Technology's infamous *9 Evenings: Theatre and Engineering*, a series of ten events held over nine evenings. With the help of Bell Labs' engineer Billy Klüver, the event brought together numerous artists, practitioners, and engineers including Simone Forti, John Cage, pianist David Tudor, dancers Yvonne Rainer and Alex Hay, and engineers Herb Schneider, Jim McGee, Larry Heilos, and Per Biorn (noted in chapter 4).

Robert Rauschenberg's piece for *9 Evenings* was *Open Score*, performed on the second and ninth evenings. It began with Frank Stella and tennis pro Mimi Kanarek dressed in tennis whites and positioned on a makeshift tennis court inside the Armory building. Behind them the engineers gathered amidst a pile of cables, wires, and control boards. The game began when the ball flew back and forth between Stella and Kanarek. Bill Kaminski designed a miniature FM transmitter that fit in the handle of the tennis racquet and a contact microphone was attached to the handle of the racquet with the antenna wound around the frame of the head. With each swing of a racket that hit the ball, the vibrations of the racquet strings were transmitted to the speakers around the armory and a loud "bong" sound would echo throughout. For each hit, one of forty-eight lights would be turned off. When the entre hall became dark, the game ended. In the dark, 500 people came onstage, after which three giant screens came on, playing back images of the viewers to themselves, captured by infrared sensors during the performance.[40]

On the surface *Open Score* appears playful, but on a critical level, as Turner points out, it serves to legitimate a certain kind of perception rooted in covert military surveillance and mass manipulation techniques.[41] By couching new informatic tracking and visualization systems within the framework of a "game," and a tennis game no less, they are stylized and aesthetically legitimated as "avant-garde" art. The implicit loss of natural human vision as a means for knowledge acquisition is effectively reframed and ostensibly neutralized. But, as similar naturalizations of military vision ensue throughout culture, enframing builds. Moreover, that technology has been used, ordered, and procured—by humans—to destructive and malicious ends in the form of bombs, war machines, or environmental ruin, no doubt contributes to a growing skepticism and negativity surrounding these new visualization systems despite efforts to resignify them.

So while the prospect of an algorithmic lifeworld sounds intrinsically dark and cynical, as almost all of the above examples suggest, recall that any positive or negative judgment of a technology is historically determined. As Nietzsche demonstrated over a century ago, any value or evaluation of a technology depends entirely on use, application, and context. The general ten-

dency to perceive hypertechnologies, especially those derived from the military-industrial complex, through a priori negative filters (which is the case from Heidegger to Habermas and the entire Frankfurt school, save for Benjamin's occasional fetishization of technology) must be seen as part of an ongoing material-historical critique of technics in terms of psychic and physiological restructuring, *implementation*, and *use*. Besides, how could an isolated object like a hammer or a piece of metal be intrinsically "bad" or "good"? Heidegger's insistence on a historical approach to technology is often overlooked in favor of more simplistic readings of technology-as-a-single-object or as superficial appeals to technological determinism. It is therefore necessary to consider some counterexamples of infrared, like *Zerseher*, *Eye Drawings*, and the work of new media artist Jordan Crandall, which deviate from fear-based fantasies to instead use the same visualization technologies to critique the algorithmic lifeworld they emerge from.

The *Eyewriter* (2010), for instance, is an ongoing collaborative project produced by the Free Art and Technology Lab (FAT), Open Frameworks, and the Graffiti Research Lab that uses infrared tracking and data parsing for creative expression (figure 6.6). It consists of a low-cost open-source custom-designed infrared eye-tracking software that enables people to draw using only eye movements. Inspiration for the piece came from Tempt1, a Los Angeles-based graffiti writer and activist associated with the GRL. In 2003, Tempt was diagnosed with amyotrophic lateral sclerosis (ALS), a disease that left him almost completely physically paralyzed, except for his eyes. *Eyewriter* was a response to this diagnosis as well as a demonstration that the appropriation of dominant technologies of control (in this case infrared military tracking systems) can introduce practical problem-solving strategies, with potential long-term benefits. Such alternative critical perspectives are also at work, though from entirely different points of view, in the use of infrared in the new media artwork of California-based Jordan Crandall, whose work I will focus on before closing the chapter.

6.6

6.6 Free Art and Technology lab (FAT), Open Frameworks, and the Graffiti Research Lab, Eyewriter, 2003. A low-cost open-source custom-designed eye-tracking software that enables one to draw using only eye movements. Courtesy of Open Frameworks and the Graffiti Research Lab.

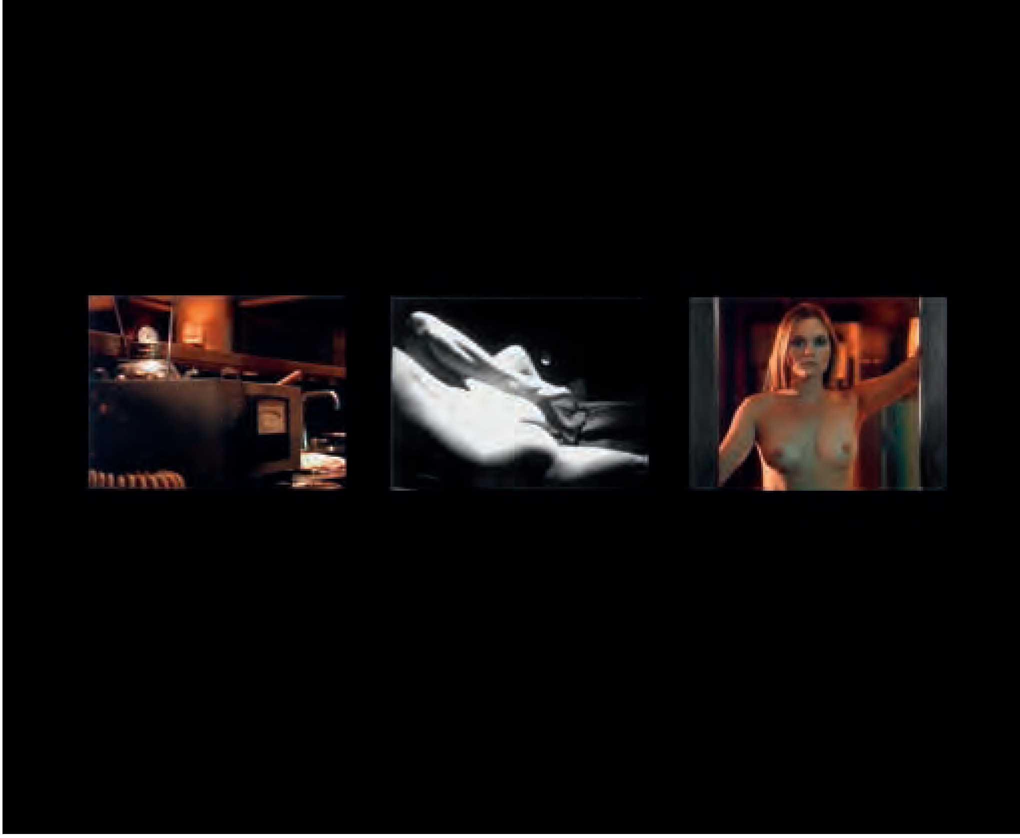
Jordan Crandall

Since the late 1990s Crandall has been using a variety of mixed media to explore what he refers to as the "dark visions [of the] the techno-militaristic control society" and the ways in which contemporary images are increasingly enmeshed within militarized complexes. Crandall is very much unlike those who, on the one hand, moralize any and all war-related pursuits as unjustifiable, aberrant, and negative—to be feared, shunned, and thwarted at all costs. On the other hand, he is also unlike those who perversely fetishize the atrocities of war and military brutality, like the Futurists or Surrealists, who celebrate war's horrors as an "aesthetic pleasure of the first order." ("Beauty will be convulsive or it will not be," André Breton wrote in 1928.)[42] Crandall refrains from either extreme, working in the margins between the human and the machine to generate alternative strategies for reality, experience, and desire in an increasingly militarized culture.

Donna Haraway has suggested that in the information age critical interventions arise through unholy fusions between humans, animals, and machines, "blasphemous" to their military-industrial origins. Computers, she argues, have become especially lively and humans, passive and inert.[43] Life is more alive when computational, and humans, when we engage them. This is by no means cynical but a mere snapshot of the way life is actually lived. The question is not "what's wrong with this picture" or how do we "oppose the big informatic system" but, given our utter and inextricable immersion in a world of computation, what are we doing and *how* are we doing it?

Crandall's *Heatseeking* (2000) was developed specifically in the context of InSITE, a joint cultural project between the United States and Mexico (figure 6.7). The project resulted from his reflections on the border region at San Diego / Tijuana, the busiest border crossing in the world. *Heatseeking* consists of a six-channel installation involving several 16 mm films and surveillance videos made at the border using miniature stealth cameras and infrared thermal imaging systems. The images are seemingly disparate: home interiors, power cables, naked bodies barely touching, a golf course at night, a naked man and woman in a navy vessel, and U.S. Border Patrol footage that Crandall appropriated of illegal immigrants crossing the border from Mexico, including an infrared satellite track of a naked woman crawling along the beach at night.

In this track, called "shore," a grainy image of a nude woman poised on all fours is seen crawling along the sand (figure 6.8). The hazy low-resolution outline of her black-and-white figure softly morphs and blurs at the edges as she moves, the result of an editing technique that emphasizes both her anonymity and her vulnerability, charging her movements with an intensified eroticism. In part this eroticism derives from the *lack* of detail and the inability to identify the woman visually or optically, a characteristic also found in night vision's cold green coloration. Marshall McLuhan's definition of "cool media" characterizes



6.7

6.8

6.7 Jordan Crandall, *Heatseeking*, 2000. Bodies and desires are targeted and caught in the algorithmic track. Courtesy of Jordan Crandall.

6.8 Jordan Crandall, "Shore" from *Heatseeking*, 2000. C-print mounted on aluminum, 12.5 × 24. Crandall uses data from infrared thermal images captured from surveillance cameras at the U.S/Mexico border to create these techno-erotic images. Courtesy of Jordan Crandall.

precisely this shift from "hot," optically detailed and uncompressed high-resolution film images, to the cooler, low-resolution, video and algorithmic ones. The old-world "vision-knowledge" couplette, reliant on detail and subtlety, is here undercut by the intentional concealment and partial visibility of the low-resolution image.

Low resolution is also a means of seduction and control. As the title *Heatseeking* implies, the woman is the target of an infrared heat-seeking system, used to monitor and patrol this highly regulated region. The infrared track brings a cold eroticism to the "hot" track. Adding to this is the anonymity and abandon with which she seems to resign herself to the global satellites that watch her, seen by everyone and yet no one in particular. Or perhaps it is also the case that the image simply captures the absence of anxiety in knowing that what happens in the dark has become as banal as what happens in the light of day. Indeed, *Heatseeking* emphasizes the way in which military intelligence and smart technologies have already become a part of vernacular culture, "a political language . . . resonant with the visual networks in which we are now entangled."[44]

This entanglement is not, however, primarily optical, as with the privileged lines of sight in the Panopticon, but instead pervasively physiological and corporeal *first*, and visual *second*. The political landscape is significantly more intrusive than the softer and more passive psychological (though hierarchical) topology of the surveillance model, but it is also for this reason that Crandall regards this perceptual system as one capable of a new kind of "care." As he puts it: "To be watched and tracked is to be cared for and this comforting gaze carries with it an erotic charge."[45] For Crandall the decline of optical vision as a cultural dominant is no reason for nostalgia or melancholy. No psychoanalytic lack or angst fuels his images. To the contrary, his reconfigurations create new conditions and strategies for life and desire *within* these series of informatic exchanges, between partial looks, machines, and pulses.

Along similar lines is Crandall's *Drive* (1999–2000), a seven-track four-channel video installation combining 16 mm film, satellite-derived photography, digital video from wearable DVcams, Hi8 video, and computer animations (figure 6.9) The images in the installation, divided into "Tracks," are also seemingly disparate: black-and-white images of a topless woman driving a car (in Track three); a naked woman standing in a small cubicle-like room, seen from overhead through a night vision filter; an infrared view of a military helicopter hovering in the sky at night; and slow-motion pictures of an elderly man spanking a young woman.[46]

The images are unified through tropes of seeing, being seen, tracking, looking, observing, watching, and to state the obvious, sexuality. *Drive* invokes a sense of "paranoid scopophilia," according to Peter Weibel, that "both escapes and invigorates a panoptic regime."[47] This may be so, and one may

6.9

presume Crandall has combined the optical and the algorithmic, but when considering all the Tracks together it becomes clear that his subjects have already been caught and made targets of the information systems, before vision occurs. This is further illustrated through the emerging figure of the exhibitionist, indigenous to the algorithmic model, and now replacing the formerly dominant figure of the voyeur from the panoptic model.

Exhibitionism as Algorithmic Ontology

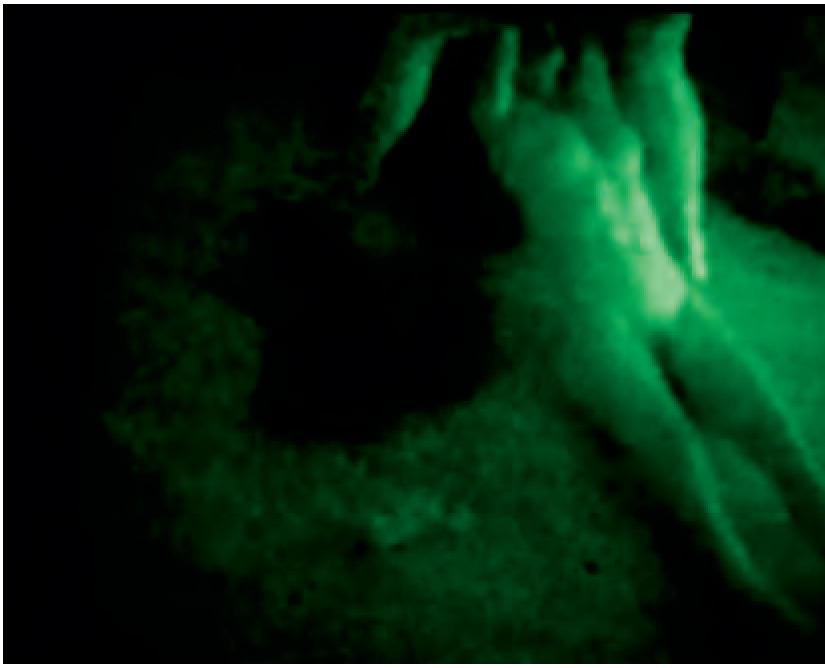
In *Drive* and *Heatseeking* it is the exhibitionist, not the voyeur, who is the erotic figure and trope of choice. It may seem odd to introduce a vulnerable naked body into a traditional military tracking system (being that much easier to control and command), but it is precisely this hyperdividuated mix of vulnerable flesh and cold command system that gives the piece its eroticism and philosophical charge. An additional example of this is in Track three of *Drive*, where a topless woman driving a car on a California freeway self-consciously puts herself on display. This is not the unknowing and passive female exhibitionist of the cinematic gaze. Rather, the new school exhibitionist is born from the generative principles of informatics and tracking circuits.[48] The woman's brazen disposition, like the nude in *Heatseeking*, mimics the cold and undiscriminating eyes of the satellite systems that track her as she drives. In another sequence from Track three, a naked woman stands in a small cubicle-like room and changes, seen overhead from the point of view of a small night vision camera. She moves things around; knows she is being watched, but instead of showing embarrassment or shame, she performs for the camera. Without directly looking at it, she mirrors its sturdy but indifferent attentiveness.

6.9 Jordan Crandall, *Drive*, 1998–2000. Installation view of Tracks 3 and 6, Neue Galerie Graz. This four-channel installation explores emerging models of algorithmic perception though infrared and night vision technologies. Courtesy of Jordan Crandall.

In the past we may have considered things like human interactions "with" a computer, where the two entities were understood as discrete, but now we have "activity-systems" where human and machines are synthesized in a hyper-dividuating feedback loop. Exhibitionism becomes a precondition for life, desire, and existence, whether visual or otherwise. Moreover, because infrared tracks are dynamic and occur in real time, the figure of the exhibitionist highlights the way in which these circuits bear a *performative dimension* and are thus open to intervention and change in ways that the surveillance model is not. For example, a person *can* alter a data pattern by adjusting their own behaviors to meet—or trick—the capture devices. At the same time, the performative aspect of the system could be used for more pernicious and unprecedented forms of behavior control and work "optimization." For instance, a worker's patterns may change due to the presence or absence of sensors strategically placed in workstations around a facility, as with Olivetti's black badges. Herein lie both positive and negative applications of the infrared model in regards to hyperdividuation. The trope of the exhibitionist is key because, unlike the classical exhibitionist in the voyeur model, he or she can exploit the system through display and spontaneous performance, just as Paper Rad's animations—as discussed in the previous chapter—undermine expectations for smooth and seamless media consumption.

To become this kind of exhibitionist one must voluntarily enter the system, consciously become its target and prey. This is of course distinct from actual applications of tracking systems, where subjects, at the U.S.-Mexico border for instance, try to *avoid* being caught by the infrared satellites. In *Heatseeking* and *Drive*, one volunteers to be in the circuit, reaping pleasure from being caught and becoming prey to it. Crandall creatively exploits the performative attributes of these systems by allowing his actors to mechanize their gestures in a *perverse way*. The actors shape and adapt their erotic drives to meet the new rhythms of the informatic machine. In track three of *Drive*, the images of the woman being spanked are mechanical, without the hyperbolic sexualization that one would normally see in this kind of scenario. They instead bear a perfunctory anonymity, showing how the woman performs not for the man "playing" the sadist, but ultimately for the cold, uncompassionate quantizing system that has caught both of them (figure 6.10). Submitting to the track, the logic of the machine, Crandall argues, is part of a new topology of pleasure in the information age. The former "edge" ascribed to sadomasochism or exhibitionism is here dulled, flattened into an almost unfeeling, low-resolution, and yet slightly pernicious sexiness. Crandall's work marks the shift from the voyeur or narcissist (see chapter 5) who saw and knew through the world through optics and lenses to the new world of the hyperdividuated-exhibitionist who comes into being through the collective intelligence of human-computer exchanges.

If the second half of the nineteenth century through the early twentieth is characterized by a "frenzy of the visible"—a process that led to the total



6.10

reification and mechanization of visual images—what Guy Debord identified as the commodity form par excellence—then in the information age, the equivalent becomes the strategic use of algorithms not just for the production of visual knowledge but also to engender desire and life experience. The algorithmic exhibitionist can be seen as the new agent and provocateur demonstrating that it is only *through* dynamic and interactive information systems, which are part visible and part invisible, that being and desire become. The *act* of showing—posting, blogging, logging in (one need not show naked flesh or even a visual image to be an algorithmic exhibitionist)—has come to replace the passiveness of looking. Showing occurs not *for-an-other* but in order *to be*. What counts is that one can, does, and must produce oneself—produce existence—through this new "democratic" mass medium where one is finally "empowered" to interact. Enforced interaction is therefore also a facet of hyperdividuation. The *fact* of a data transfer trumps old-world values of nuance, detail, and above all, signification. Affirmation of life comes from the successful encoding and decoding of a signal: one either is or is not. Just as it is with infrared imaging, data is made to appear through hypertechnological means where content and nuance are bracketed out. Mirroring this process is the exhibitionist, underscoring how, in the algorithmic lifeworld, we have (again) become "a different subject from man, something other than the human type."[49]

In sum, the algorithmic exhibitionist reflects broader technological and cultural changes from the private domestic world of media consumption, of television or dark movie theaters, to a public domain of peer-to-peer social

6.10 Jordan Crandall, "Track 3" in *Drive*, 1998–2000. A naked woman seen overhead through a night vision filter.

media in a “millennial cam girl universe,” as Bruce Sterling puts it. Consider the billions of semi-anonymous YouTube videos depicting “private” thoughts, fantasies, diaristic secrets and fears—whether verbally, visually, or otherwise. For many young people, so-called “private” or “domestic” lives, whether social, sexual, or otherwise, are often meaningless because their lives have been lived online from the start. Exhibitionism is inscribed and prescribed in modern life, even when one does not desire it. In order to be a functional and productive member of society, one must accept these conditions. *How* this acceptance occurs, however, remains (in some cases) open.

Post-optic Visions

Equipped with an infrared camera, would Jimmy Stewart of *Rear Window* have seen too much, through walls and curtains, or would he have seen too little, denied optical detail and nuance? The question is vital because in practice optic and algorithmic systems are often integrated and the difference between them is obscured. In order to create awareness of the epistemological and ontological changes we face in algorithmic culture, in this chapter it has been necessary to separate them, as summarized in the table. *Rear Window* is an example of the optical model, which emphasizes visual metaphors and watching from a safe and passive distance, where those being watched may not even be aware that they are being watched. In contrast, the algorithmic model—exemplified by *Heatseeking* or *Predator*—relies on the capture of data as information units, where color becomes a function of a dynamic information system in which users are literally and physiologically fused into the (invisible) track and capture logic.

My arguments for a decline in the optical image in exchange for a rise in algorithmic visualization as a new cultural dominant is not so much about an obsolescence as it is about the way in which perception and experience are increasingly shaped and structured by the logic of informatics and data capture systems. While many examples—ultimately any real-time computer-generated digital image—could have been used to illustrate this argument, I chose digital infrared because it is a color naturally invisible to humans, and thus any presentation of it highlights the shifting boundaries between the visible and the invisible, and the ways in which this occurs through the enculturation of military-industrial intelligence and weapons systems.

Somewhat similar observations have been noted by Rey Chow in *Age of the World Target*, by Phil Agre in “Surveillance and Capture,” by Paul Virilio under the heading of “speed politics,” and by Gilles Deleuze in his articulation of the “society of control.” However, there are differences: for instance, Chow argues that the “target” logic derives purely from the optical tradition.[50] In contrast, infrared, because it falls beyond the range of human vision even when

	Optical Vision	Algorithmic Image
Period	Eighteenth through early twentieth century Michel Foucault's "Disciplinary Society"	World War II through the present Gilles Deleuze's "Society of Control"
Mode of production	Humans, with the aid of optical devices or visible evidence, "witnessed" in the visual or empirical world. Re-presentation or copying through mimetic or indexical means.	Information machines use sensors to track, capture, and scan a target that is then quantified through algorithmic processing, in real time Simulation, transcoding, and translation between two dramatically different languages/systems So-called images exist only as an adjunct to algorithmic processing and information transfer (data visualization/information aesthetics)
Visual epistemology	Fixed subject-object positions; passive perceiver is privileged over the perceived object (highly gendered pairing). Theories of the gaze (voyeurism, surveillance), optics (Panopticon, centralized structures of power) Logos of the eye; conflation of truth, knowledge, and vision	Subversion of traditional subject-object relations because the human is physically immersed in feedback circuits. One's body becomes the source of data. System is not fixed but open and flexible (through exhibitionism or interactive performances). A priori programming determines future knowledge.
Psychological metaphors	Voyeurism and scopophillia Narcissism (chapter 5), identity Private/domestic life and desires, viewing habits for discrete spaces Subject effect created through surveillance apparatus	Exhibitionism; anonymity in profiles and user names (hyperdividuation) Self-affirmation through public display and interactivity (hyperdividuation) Perceived surveillance becomes nonissue in exchange for the affirmation of existence gleaned in the act of self-display

Table 6.1 Two models of perception: the optic and the algorithmic.

aided by optical prosthetics, illustrates the way in which digital images are, from the start, produced by and through information technologies—algorithms—not optics and hence they are “post-optic.” The image, if there is one, *is always an adjunct to the algorithm*.

It may seem like a small bone to pick: yes, colors and images are increasingly generated and manipulated through mathematics and not by optics or natural vision, so what? But consider: should the current forces driving the logic of algorithmic processing proceed unchecked, what would it mean to live in a society where all forms of experience become a question of economic exchange; always seeking and favoring interactions that tend toward cost and transaction reduction? How would we go about imposing algorithmically precise formulas on previously unformalized qualitative relations—such as love, desire, anger, or rage? What are we to do if, in fact, “the basis for the emerging universe and consciousness,” as Flusser puts it, is restricted to the “calculation of probability”? Or if, as Stiegler suggests, we have come not to the end of the human (we are already posthuman) but rather to the transformation of the human to such a degree that we are no longer able to access or communicate with other beings? Critical attention to the material and ontological processes involved in algorithmic processing opens up broader questions concerning social and cultural operations: the production of visual knowledge, concerns about privacy, shifts in the political and economic infrastructure, and perhaps most importantly, what it means to be human, alive, and desiring in the algorithmic lifeworld. These questions are pressing, yet there are no easy answers. The shaping of future societies depends on attentiveness to the particularity and context of algorithmic visualizations, and above all, when we remember that new media are not just passive “tools” but rather, they are historical, social, and political agents that play active roles in shaping who and what we are and could and will become.

In the next chapter, the final one before the postscript, I take the ideas introduced here and translate them into a theory of an emerging visual style that I call the “Photoshop cinema.” Just as this chapter argued that contemporary digital color, in the form of infrared images, has more to do with cold and inscrutable algorithms than with optics or the nuances of subjective expression, so too does my theory of the Photoshop cinema argue that digital colorism is today more concerned with an informatic and cool indifference. Chapters 6 and 7 thus work together as two sides of the same Janus-faced coin: the cold inscrutable logic of the invisible algorithm and its corresponding opaque, yet highly saturated, visual style.

Chapter Seven
The Photoshop Cinema

Concern with effect rather than meaning
is a basic change of our electric time.

—Marshall McLuhan, 1964[1]

American artist Jeremy Blake (1971–2007) is known for his mysterious time-based digital paintings. Yet shortly after his untimely death, investigations revealed hitherto unknown details about his production technique and in particular his reliance on a certain piece of software:

> They discovered Mr. Blake's labeled folders in Adobe Photoshop, the graphics-editing software. Each folder contained sequential picture files with titles. But within each dense file were numerous layers of the artist's "moving painting" imagery, their intended direction and flow indecipherable.[2]

Why has this fact since been ignored? Perhaps Blake's dependence on template-driven, automated commercial software in the production of fine art is too abrasive, embarrassing even, to the art world and its mythology of the genius-artist? Regardless, the fact remains: Blake's luminous and mystically colored time-based paintings originated in Adobe Photoshop and bear the trappings of this prefabricated and machine-made framework. Thus we are invited to consider what Adobe Photoshop is, what it means for contemporary aesthetics, and how the use of software applications like Photoshop conditions and alters creative production today.

In this chapter I argue that Blake's cinematic artwork, complemented by such feature films as *Pleasantville* (2000), *Sin City* (2005), *Waking Life* (2001), *A Scanner Darkly* (2006), and *Speed Racer* (2008), is characterized by highly stylized uses of digital color that I call the Photoshop cinema. The Photoshop cinema involves the use of saturated, thick, digital color that figure as stylistic *and* conceptual opacities in regards to meaning, narrative, and image. By stylistic opacity, I mean the literal use of thick and rich colors, generated through Photoshop or similar software applications. By conceptual opacity I mean artwork characterized by an impenetrable style of cool, almost aloof indifference. Together, these stylistic and conceptual opacities constitute a new paradigm of digital colorism in contemporary media aesthetics.

The new school colorism bids adieu to expressionistic palettes and subjective color values, welcoming instead the prêt-à-porter convenience of store-bought color, prefabricated software layouts, and designed effects. Its sensibilities are similar to the way in which Charles Riley describes the colors featured in the Museum of Modern Art's 2008 exhibition *Color Charts: Reinventing Color, 1950 to Today*. "These colors," he writes, are without the "familiar litany of harmony, cool versus warm, synaesthesia, simultaneous contrast, complementaries . . . Goodbye Goethe and his colossally inspiring errors—hello Benjamin Moore." And while this exhibition featured almost exclusively the industrial colors of modern painting, with only a couple new media and photographic works, Riley's observations very much apply to my concept of the Photoshop cinema and the new conditions of postindustrial color.[3] For the moment, however, I must put this term aside and allow the chapter to do the intricate work of unfolding the details of the new paradigm of cool indifference.

My arguments in this chapter are thus concerned with a new style of colorism,[4] analyzed primarily through the gallery projects developed by Jeremy Blake, which I connect and compare to broader histories of color within Western painting, cinema, and the avant-garde, especially the structuralist films of Paul Sharits. More broadly, the chapter takes chapter 6's insights into post-optic algorithmic color and offers a corresponding visual style that is also unconcerned with hermeneutic depth or optical detail. In other words, if algorithmic color is code first and image second, then what kind of visual sensibility *can* emerge? The answer, as I will demonstrate, is one that deals in patterns and simulated surface effects through so-called transparent interfaces. As the last of the core chapters in the book, the Photoshop cinema shuts the door on the once-expanding field of optical perception, utopian ideals, and progressive visions that, several decades ago, birthed these colors (in chapters 2 through 4).

Digital Color

In the 1990s, as discussed in the second half of chapter 5, digital electronic color became synonymous with mass media, mass consumerism, and Internet commerce. Even in popular cinema and feature-length films, digital colors were choreographed and designed using color-grading techniques, a sophisticated form of color compositing, or chromakey, as analyzed in chapter 5. In the film industry, the technique has become unequivocally associated with digital intermediate (DI) technologies, which involve scanning an original film into a digital platform, manipulating it, and then (less frequently) "baking" it back onto the original format for distribution.[5] Accordingly, the examples I discuss in this chapter have been selected for their use of stylized digital color grading. And while high-end films do not use Photoshop software to accomplish this, they do use similar though more sophisticated and often customized software. For example, in *The Aviator* (2004) director Martin Scorsese commissioned a team of programmers to write a set of LUTs. A LUT, or "look up table" is a set of indexed numeric values that correspond to particular precomputed colors for a film sequence or set of images in a scene. Scorsese's LUTs emulated the "look" of 1930s and 1940s Technicolor film stock, the time period the film was set in. Here, algorithmic color was used to generate a more precise color than actual Technicolor color.

Jeremy Blake

Between 1998 and 2007, Jeremy Blake made nineteen colorful "time-based paintings," each running from three to twenty minutes and on occasion longer, though the work is often shown in a loop, making length somewhat irrelevant. His work is exhibited on plasma screens, as projections on gallery

walls, museums, or in private collections. Blake has collaborated with such established directors and musicians as Paul Thomas Anderson in *Punch Drunk Love* (2002), Lars Von Trier for the opening sequence of *Dancer in the Dark* (2000), and Beck for his album *Sea Change* (2002). He has also created several illustrations, large C-prints, and mixed media images, which tend to be thematically connected to the time-based work.

Blake's subject matter derives from the culture and history of southern California. As he puts it, "stilted dialogue, cheap special effects, and the prefab accouterments of success (hot tubs, vacation homes, powerful drugs . . .)" selected from "Hollywood's psychic dustbin."[6] The city of Los Angeles plays a key role in *Chemical Sundown* (2001), and Hollywood features prominently in *Century 21* (2003) and *Bungalow 8* (2001). The American frontier and the Wild West are the subjects of the *Winchester Trilogy* (2002–4), while the former punk rock subculture lies at the heart of *Glitterbest* (unfinished, 2007) and fashion, drugs, and music are prevalent in *Reading Ossie Clark* (2005), *Angel Dust* (2001), and *Sodium Fox* (2005) (figures 7.1 and 7.2).

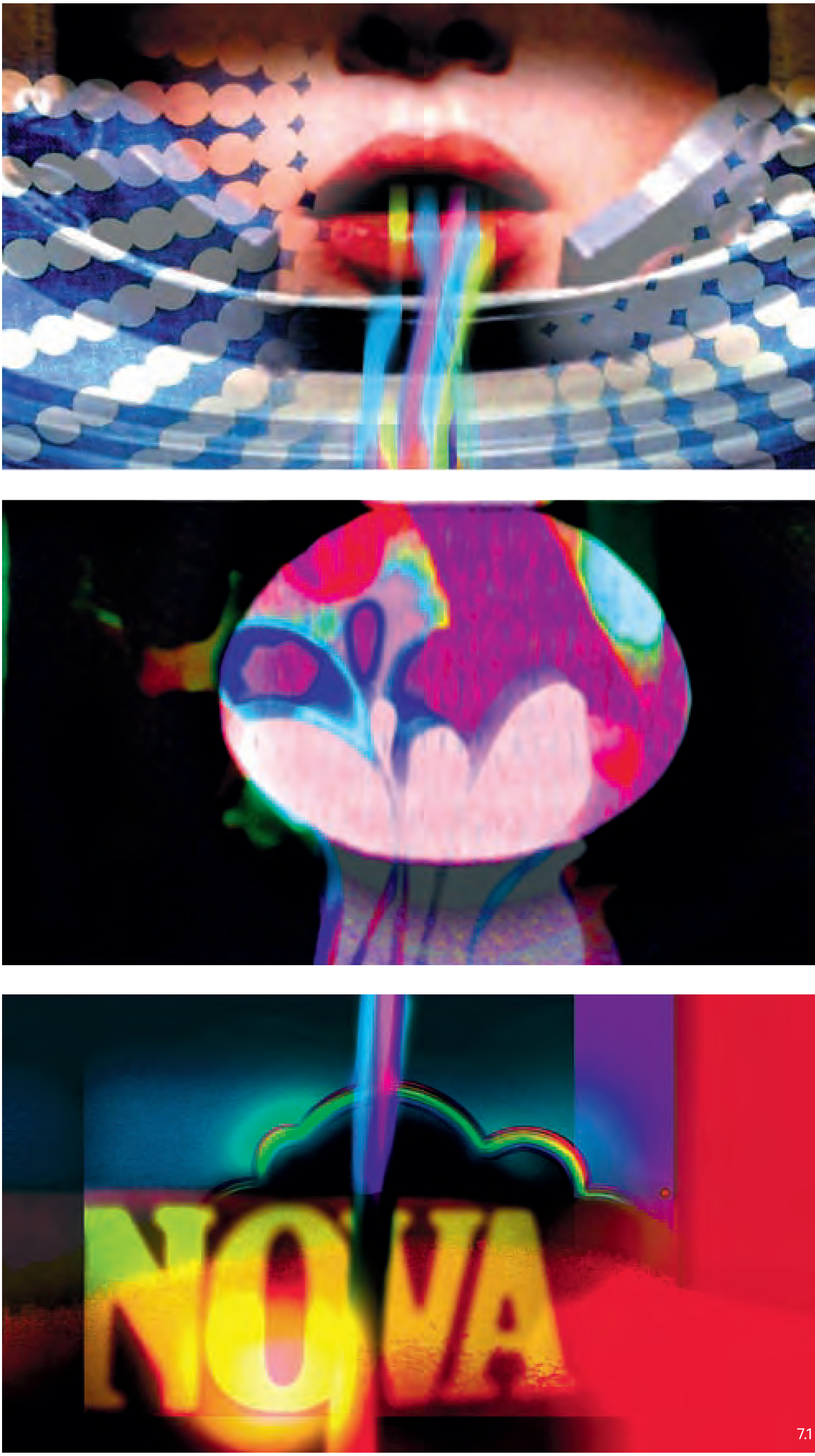
But what are these thick, opaque, and highly saturated patches of color, so characteristic of Blake's style, doing on the surface of the screen? Do they complement the viewing experience, or block it? These are important questions, and while the bright lights and luminous colors of the southern California landscape must certainly influence the artist's palette, one must also carefully examine the relationship between color and narrative before making further claims about them.

One of the most identifying traits in Blake's work is his use of saturated color juxtaposed with photographs, film clips, or vintage imagery, which he uses as a stylistic device that alludes to the historical and aesthetic debates between *colore* and *disegno*. As noted in the introduction, in art history the term *disegno* denotes line, compositional coherency, narrative ordering, and drawing skill, whereas *colore* denotes colorism and color treatment, traditionally through brushstroke. The two were pitted against each other, most notably at the height of the Italian Renaissance, with Florence's *disegno* and Venice's *colore*. When examining Blake's time-based paintings as a whole, it becomes evident first that his work plays off of these debates while also positioning itself at the intersection of the histories of colorism in film *and* modern painting, and second that a shift develops in the use of color throughout his work: from geometric and rigid uses of color in his early work, to the addition of explicit narrative and more fluid uses of color in his later work.

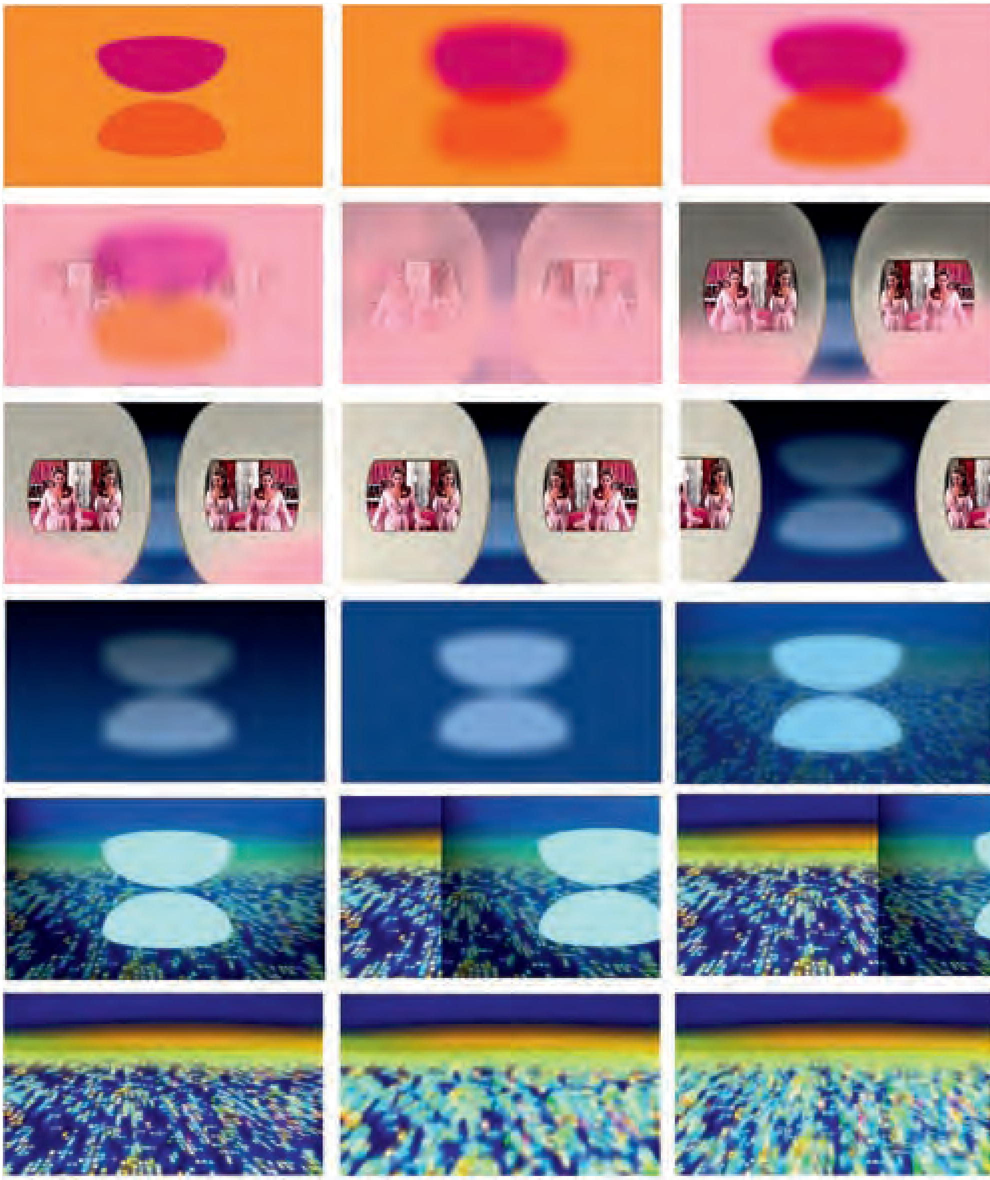
Narrative Saturation

The most mysterious aspect of Blake's work is his use of color in relation to narrative. Narrative has always been present in his work, even before he





7.1



7.2

turned to time-based media. Lance Kinz, Blake's art dealer and director at the Kinz & Tillou gallery in New York, explains that his early C-prints (the "mother" of his time-based paintings) are oriented horizontally, requiring the eye to move from left to right, suggesting narrative development.[7] At the same time, Blake's treatment of narrative, like his treatment of color, is idiosyncratic, cool, and orthogonal to conventional uses.

There are two predominant uses of color in the history of the moving image: either to support narrative and the formation of coherent meaning, as with films like *Ramona* (1936), *A Star Is Born* (1937), and *The Aviator* (2000), or to block them, as with *Punch Drunk Love* (2002) and *Dancer in the Dark* (2000), both of which Blake worked on (figures 7.3 and 7.4). The first approach is the most common in feature films and, as Scott Higgins has shown, is clearly illustrated in Technicolor's battles with color from the 1910s through the post–World War II period. In strident attempts to naturalize their new color stock, Technicolor went to great lengths to yield an otherwise unruly color technology into an established standard that would support, rather than disrupt, narrative cinema.[8] In this approach, color disappears in the narratavized content to the extent that it is subordinated and made submissive to it.

The second approach uses color to sensationalize, seduce, or invert and disrupt narrative and the consistent formation of stable meaning. This technique has appeared throughout twentieth century advertising and has had debut moments in cinema history, such as the hand-coloring and tinting fads developed in the era of silent film, which, as Tom Gunning has pointed out, had the effect of inciting visual desire and disrupting narrative flow.[9] Also associated with this approach is the use of color to depict nonnormative, mind-altering experiences, such as a dream sequence or drug trip. Perhaps the quintessential example of this is the LSD scene in Dennis Hopper's *Easy Rider* (1969), where photographic sequences are intermixed with abstract colors, aligning color's appearance with mind-altering substances and psychedelic consciousness (figure 7.5). For the most part, however, using this approach as the *primary* mode of address has remained largely unpopular throughout the twentieth century cinema, though it has regained currency in recent years, for reasons I will explain below. Ultimately Blake employs both of the above techniques to some degree, but his development of the latter is by far the most prominent and sophisticated; a technique that returns color to associations with transgression and the dirty matter of materiality, as discussed in chapters 1 and 5. Before returning to this intervention in Blake's gallery work, I first discuss color's relationship to narrative *inversion* and *elevation* in recent feature films (two of which include works by Blake) and the midcentury cinematic avant-garde.

Not only has the insertion of abstract and nonfigurative color had a temporary and fleeting effect in cinema, but such uses inevitably end up

<< **7.1** Jeremy Blake, *Reading Ossie Clark*, 2003. Sequence from digital animation, 9 minutes continuous. Luminescent and saturated colors ooze out of a still photograph of a woman's mouth. Courtesy Kinz + Tillou Fine Art.

< **7.2** Jeremy Blake, *Chemical Sundown*, 2001. Sequence from digital animation, 12 minute continuous. One of the first photographic images to appear in Blake's time-based work. Courtesy Kinz + Tillou Fine Art.

7.3

7.4

supporting and intensifying the narrative form. In other words, the appearance of color in this second approach is often restricted to pseudo-disruptions of narrative, i.e., to represent what was “only” a dream, moment of rage, or hallucination during an LSD trip, after which the film returns to its logical and cohesive narrative trajectory and color disappears back in it.

In 2002, after analyzing recent special effects in mainstream Hollywood cinema, film scholar David Bordwell identified a new narrative style that he termed “intensified continuity.” Contrary to the claims that the Hollywood style has become “post-classical,” he argues, “we are still dealing with a variant of classical filmmaking . . . Far from rejecting traditional continuity in the name of fragmentation and incoherence, the new style amounts to an *intensification* of established techniques.”[10] Bordwell was referring to the now popular effects of time remapping and increased cuts in montage sequences, effects that have been used since the early days of cinema, now regaining popularity, in part due to the new ease and availability of digital media.

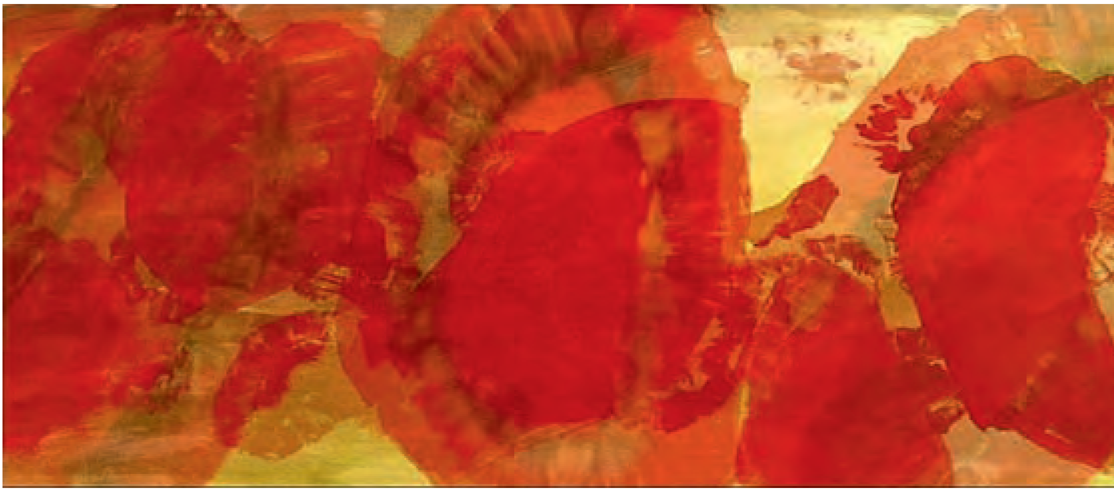
I here extend Bordwell's argument by shifting his terminology from narrative *intensification* to narrative *saturation*. The purpose is twofold: digital color techniques can simultaneously intensify the narrative form *and* the aesthetic of the visual image as it appears on screen. This doubling occurs because digital colors are flexible and capable of high degrees of saturation and luminosity, but also because of the way in which color can be used to interact with (narrative) form. My concept of "narrative saturation" thus builds on Bordwell's intensification thesis by reversing the traditional Western binary that privileges form (*disegno*) over *colore*, and instead allows hue and saturation to take an active role in critique. This is not a straightforward reversal where *colore* simply becomes the priority term; rather, the issue becomes the relationship *between* the two.

Blake's technique of narrative saturation is most evident in the segments he created for two feature films: Paul Thomas Anderson's *Punch Drunk Love* (2002) and Lars Von Trier's *Dancer in the Dark* (2000). In *Dancer in the Dark* the purely abstract, nonreferential colors invoke an aesthetic of sightlessness, a metonymy for the story line that develops through the visually impaired protagonist Selma (played by Björk) (figure 7.6).

7.5

7.3–7.4 Jeremy Blake, luminous color sequences in dir. Paul Thomas Anderson's *Punch Drunk Love*, 2002. Film stills.

7.5 Dir. Dennis Hopper, *Easy Rider*, 1969. Film still. This acid-trip scene occurs in a graveyard in New Orleans, depicted through a stunning montage sequence intercut with photographic sequences of ecstatic bodies and abstract colors.



7.6

Unlike the singular use of opaque color in the introductory sequence to *Dancer in the Dark*, *Punch Drunk Love* presents abstract color sequences and color overlays several times throughout the film. Film scholar Brian Price argues that these sequences halt the narrative flow, bringing its contrived status to the surface of awareness. For Price, Blake's sequences in *Punch Drunk Love* instantiate a trend in American and international cinema to use color abstraction to ultimately block narrative development and "overwhelm the narrative space" leading to a "state of entropy; [where] streaks of color undo the image."[11] Certainly these color bursts halt the image, but as one idiosyncratic scene leads into the next, these brief color bursts and chromatic layering effects function just as easily as transitions that bind the viewing experience together. In other words, the momentary pauses of color function as connective bridges within an already fractured postmodern aesthetic.

A first example of this occurs in the opening scenes of *Punch Drunk Love*. Just after the protagonist, Barry Egan (played by Adam Sandler) appears in an awkward royal blue suit, the camera pulls back to reveal an equally odd royal blue and white striped room (figure 7.7). Both seem idiosyncratic yet continuity is forged between their mutual eccentricities: an offbeat guy and an offbeat workspace. When the film cuts to an abstract color animation shortly thereafter, the viewer is already primed to carry over the visual metaphors—from meaningful color symbolism in the blue suit and a blue painted room, to more abstract and less referential color. This continuity unifies an offbeat set of abstractions, within an equally offbeat and idiosyncratic film, resulting in a cohesive narrative framework.

A second example occurs during Barry's phone sex encounter. Though perhaps a tongue-in-cheek poke at a cliché from the Hays code era, the symbolic use of free-floating color stands in as a symbol of orgasm. Viewers connect the subjective, psychosexual reality of the character with the otherwise

noncontingent color abstractions on screen. In a third instance, color overlays appear onscreen while Barry is enraged on the phone with the phone sex supervisor (played by Philip Seymour Hoffman), seeking revenge for a phone sex scam. A similar tongue-in-cheek cliché is at work when the supervisor's irrational state is symbolized by abstract color on screen. Madness, like idiosyncrasy and sex, are easily reabsorbed into the narrative as an irrational but acceptable aberrations. In all of these cases color appears to halt logic and sense and saturate its coherence with an abstraction of hues, but ultimately the film does the exact opposite. The semblance of nonmeaning is resubsumed into the larger logic of the story and character motivation, in effect saturating, intensifying, and expanding the range of rhetorical devices in Hollywood's commodity par excellence: the narrative form. 7.7

Similar examples of narrative saturation are found in the single red gunshot at the end of Hitchcock's *Spellbound* (1945) and in Steven Spielberg's *Schindler's List* (1993), where digital grading is used to color a single red coat within an otherwise black-and-white film. Because the color red in *Schindler's List* is used as a symbol that looks backwards and forwards at once, according to film scholar John Belton, it is not "realistically" motivated but is instead "artistically" motivated, and thus the painterly use of color problematizes narrative coherency, Belton argues, and violates homogeneity and diegesis.[12] But as demonstrated, such brief moments of incompatibility hardly destroy the

< **7.6** Jeremy Blake, still from his introductory sequence to dir. Lars Von Trier's *Dancer in the Dark*, 2000. The abstract imagery echoes the film's motif of blindness.

7.7 Dir. Paul Thomas Anderson, Stills from *Punch Drunk Love*, 2002. Throughout the film, the rich colors of the set design, chromatic overlays, and costumes complement Blake's opaque color sequences made for the film.

overall structure; rather they are used as exclamation points to offset and thus heighten the dramatic tension.

Such brief interludes and uses of color saturation are common in feature films like *Natural Born Killers* (1994), *Pleasantville* (2000), and those cited above, which tend to employ digital grading techniques to fuse opaque color palettes with traditional black-and-white film and photography, live-action footage, or computer-generated animations. While visually enticing, these abstract and saturated color palettes ultimately offer a pseudo-disruption that, again, serves to *intensify narrative* and its relation to formal clarity, linearity, and thus chromophobic ideology. In *Pleasantville*, for example, color is initially introduced as a wild and transgressive excess, but by the end of the film, it has become the perceptual and realistic norm; full color is the everyday, objective reality. A film ostensibly about celebrating color's unruly power, Belton notes, ends up reinforcing homogeneity and convention.[13]

These two modes of colorism are not new. As noted, they loosely echo the long-standing debates between color (*colore*) and form (*disegno*), in a new medium. And yet when one considers Blake's gallery work, one encounters a new problem: a color treatment that moves beyond both Bordwell's concept of narrative intensification and my own concept of narrative saturation. Starting with moments of narrative saturation and temporary blockage, Blake then pushes his colors further, unwilling to allow them to rejoin the plot, its logic, or causality. In other words, Blake's gallery work exhibits a *use of color dedicated to the intentional and sustained mystification of narrative logic*. If the trend in contemporary digital cinema is to use opaque colors to introduce temporary and ephemeral distractions, only to resaturate and intensify narrative, then Blake's gallery work offers something else: *an inversion and critique of this technique*.

Color Contexts: Paul Sharits

While Blake's digital colorism is clearly prefigured in modern painting and experimental cinema, he also uses color in ways distinct from these predecessors. As he allows color to push away logic, coherency, and order, color affects become expressive in and for themselves, liberated from subordination to narrative, meaning, and form. These nonfigurative color techniques are not common in feature films, save for examples like those noted above, where they are employed as temporary and fleeting effects. These techniques *are* quite common, however, if not normative, in modern painting and this is why the color field painters Kenneth Noland, Gerhard Richter, Ellsworth Kelley, and Yves Klein together constitute one core set of interlocutors for Blake. A second set is found in structuralist film from the midcentury avant-garde, and more broadly, in the work of experimental film colorists like Stan Brakhage, Len Lye, Hollis Frampton, Gerhard Richter, Norman McLaren, Oskar Fischinger, Kenneth Anger,

and Paul Sharits, all of whom use color in ways that suggest interesting comparisons and connections to Blake's work. In particular, it is in the work of Paul Sharits that one finds an extremely elegant dialectic between color and narrative that is perhaps the most complementary—precisely because it is also so distinct from—Blake's use of color and narrative. 7.8

Sharits' *T,O,U,C,H,I,N,G.* (1968), for instance, dedicated to and starring poet David Franks, is a twelve-minute color 16 mm film that alternates "violence with purity," as P. Adams Sitney puts it, which is to say representational photography and abstract color fields[14] (figure 7.8). The photographs feature the face and upper torso of Franks, beginning with fairly neutral images that, midway through the film, become violent and sexually explicit. As the photographs flash on and off, they are interspersed with full frames of color. By the end of the film the colors are intercut with scissors, blades open, pushed up to Frank's mouth. The effect is intense, passionate, and corporeal. The almost inaudible sound track complements the expressionistic treatment of color. It consists of one sound bite, the word "destroy," repeated with overlay, distortion, and cutting until it sounds something like "touching." The play and alternation between color fields and photographic imagery mirrors the play between audible and inaudible sounds and words. The switching occurs at a rapid and aggressive pace that in turn creates a layer of flickering and stroboscopic effects. The film, as Simon Field writes, "operates at the limits of perception (and possibly tolerance)" or, as Sharits himself puts it, as an "assault on the eyeballs."[15] Color here is clearly optical and concerned with the materiality of subjective vision.

7.8 Paul Sharits, *T,O,U,C,H,I,N,G.* 1968. 16mm, color, sound. 12 minutes. Film still. Courtesy of Paul Sharits Estate and Christopher Sharits.

This same dialectic between color (*colore*) and form (*disegno*) is at work in other films by Sharits, though it often seems as though color dominates and consistently wins out over the narrative elements (for example, *Ray Gun Virus* [1966]; *N:O:T:H:I:N:G* [1968]; *Shutter Interface* [1975]; and *Analytical Studies IV: Blank Color Frames* [1975–76]) (figure 7.9). At the same time, given Sharits' minimalist aesthetic, even the smallest, single frame of content may be enough to maintain an active relationship between color and narrative, suggests M. M. Serra.[16] For instance, in *Epileptic Seizure Comparison* (1976), for several minutes one sees only pure and solid color fields flashing on the screen until fragments of archival footage of two men undergoing epileptic seizures redirect the viewer's attention to a narrative register (figure 7.10). Sharits also slows down this archival footage, imbuing the men's experience with acute visceral pain: rolling eyes, dropped jaws, and twisted necks with heads thrown back, hooked up to electric wires and plugs on a hospital bed. The interspersed color accentuates the affect for the viewer, making the black-and-white images appear frozen and prolonged in the sensation of pain. The soundtrack is equally visceral, relaying the frequency of the patients' brain waves as they undergo these extreme situations. In the last third of the film, the monochromatic color frames come back in, still interspersed among the photographic images, but dominant enough to align color (once again) with physiological illness and that which is beyond reason and control.[17] Sharits' cinema is on the whole less concerned with story than it is with affect and color sensation, with all of its erotic, violent, visceral, haptic, and transgressive attributes, and this is why he is such an important predecessor for Blake. Both actively negotiate the relationship between photographic imagery (as narrative signifier) and color abstraction.

And yet, while Blake may have been influenced by the work of Paul Sharits and other avant-garde painters and filmmakers noted above, it would be a mistake to put his work exclusively into this lineage. For one, many of these filmmakers worked with color by hand—applying it frame by frame with a paintbrush, as Stan Brakhage did, or in pin-screen animation on an optical printer, as Norman McLaren did. The experimental filmmakers also worked with a wider color gamut and used 16 mm or 35 mm color film stock and, to state the obvious, their work was produced about thirty or forty years prior to Blake's. Another important difference between Blake's colorism and that of the cinematic avant-garde is the latter's concern with the filmic experience. For the cinematic avant-garde, film is subjective and physiological, generating a kind of visceral eye-body tactile experience where color in particular figures as something deeply emotional and expressionistic. Filmmakers and scholars who advocate this sensibility include Bruce Elder, Carolee Schneemann, Stan Brakhage, Scott Bartlett, Stan VanDerBeek, and Gene Youngblood, to name only a few. When Brakhage was viewing Sharits' *Analytical Studies III: Color Frame Passages* (1974), for example, he remarked, the "yellows begin to effect

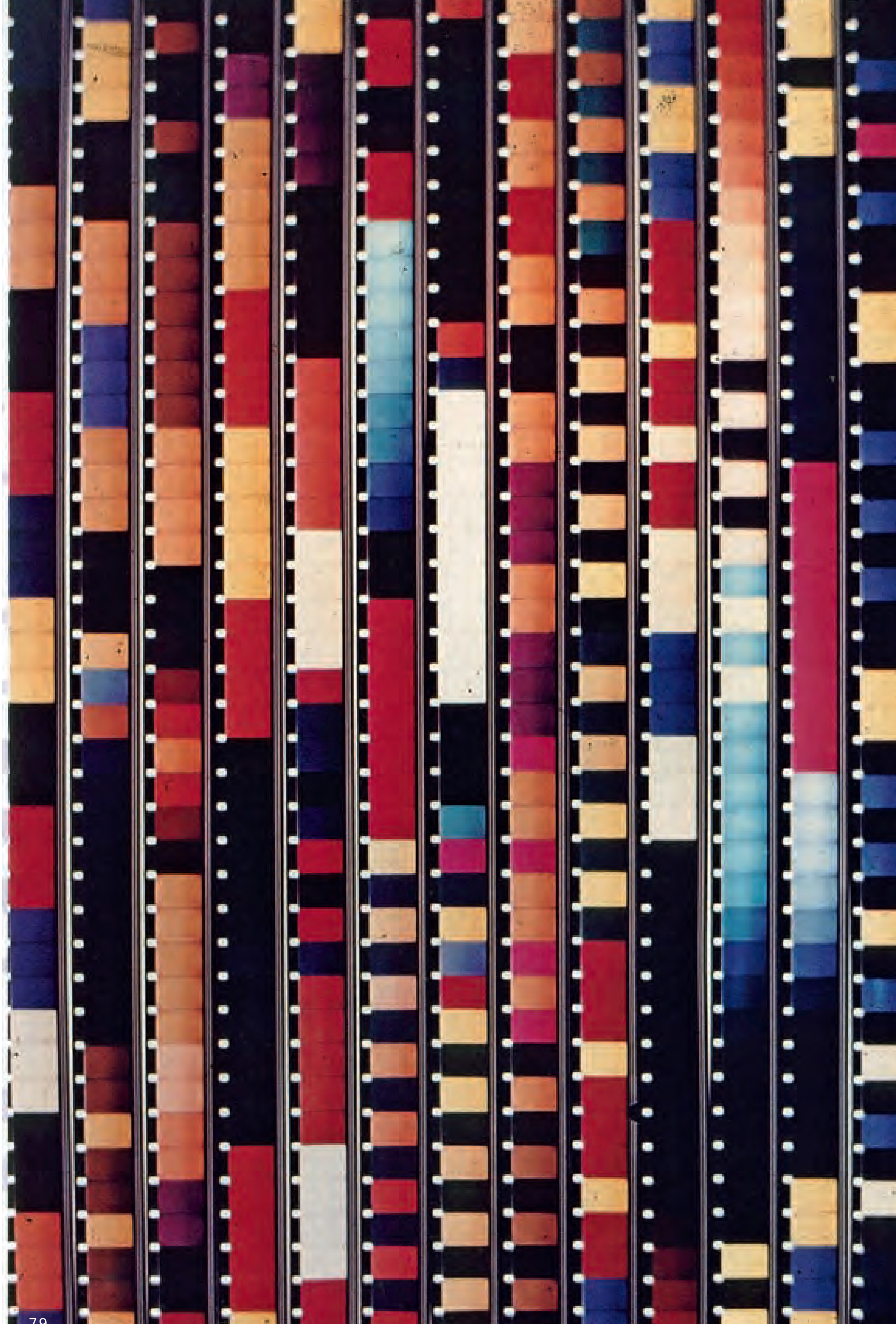
a meditative blaze . . . as-if ‘echoing’ the heating up of the body: I was . . . in [the] midst [of] a delicious healing fever cycle.”[18] In contrast, the mystical eye of color perception (the same mystical and cosmological eye discussed in chapters 1 through 4), is entirely absent in Blake’s twenty-first-century cool digital colorism (and for the most part in the work discussed in the previous two chapters). Blake’s colors are bold and saturated, but they are also flat and indifferent.

Blake’s colorism is also unlike that of a number of contemporary digital colorists who disavow narrative altogether.[19] Blake uses color to *uphold narrative tension and as a result creates an ongoing negotiation between narrative and color; meaning and nonmeaning; abstraction and representation; and past and present*. In this way, he is careful not to push color abstraction too far, to “botch” the work, as Deleuze and Guattari warn of the Body without Organs. For Blake, narrative always lingers, however dimly, in the background. To further understand this highly stylized use of color and its unique yet topical intervention in contemporary digital aesthetics, I begin with Blake’s early ventures into time-based digital art.

Blake’s Early Digital Work

On the whole, a metanarrative *about color* develops throughout Blake’s work. Chris Chang argues that Blake’s animation sequence from *Dancer in the Dark* (2000) alone visualizes the “entire history of postwar American abstraction.”[20] I extend this observation to Blake’s entire oeuvre: from the early rigid use of color to the fluid, organic uses in his later work. This trajectory offers a micro-allegory for the history of certain strands of colorism in modern painting but also, to some extent, the history of color in film, *in reverse*.

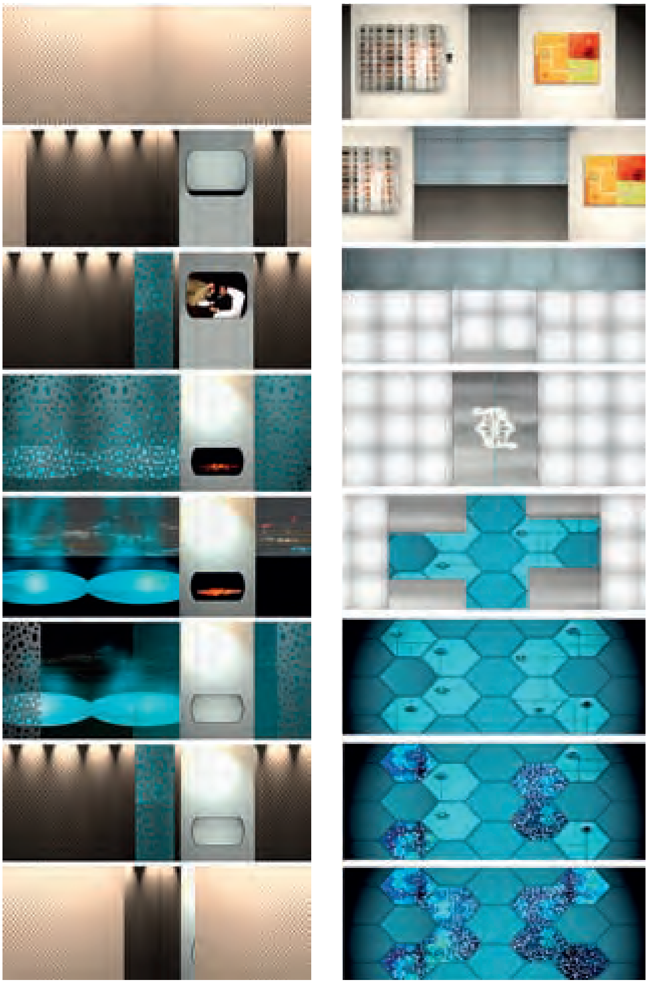
For example, one of his earliest works, *Bungalow 8* (1998), contains three parts, *Façade*, *Black Swan*, and *Hotel Safe*, all of which consist exclusively of abstract geometric shapes smoothly rolling in, off, and around the screen (figure 7.11). Abstract sounds complement the images and sprinkles of narrative distinguish it from abstract painting. And yet just as this luminous grid of colors gestures towards a story line, the screen fades to black. Narrative is understood only through an assemblage of sources, like the written description in the gallery or small hints in the images. *Bungalow 8* is a dwelling place “flanked by burning tiki torches,” an “eponymous poolside cabana at the Beverly Hills Hotel in Los Angeles, often the scene of business meetings and decadent parties.”[21] The piece was inspired by the detective mystery *Den of Thieves* (a novel Blake was reading at the time) and California noir. Beyond these kinds of fragments one’s efforts to reconstruct the narrative in full are futile. Aside from the above noted sources, the clues in the images are indirect and doubtful. In fact they actively work *against* coherent meaning. Like the noir crime story


7.9

7.10

< **7.9** Paul Sharits, *N:O:T:H:I:N:G*, 1968. 16 mm, color, sound 36 minutes. Color film strips between acrylic glass. Courtesy of Paul Sharits Estate and Christopher Sharits.

7.10 Paul Sharits, *Epileptic Seizure Comparison*, 1976. Film stills, 16mm, color, 34 minutes. In the film, one sees only color until archival fragments of two men undergoing seizures are interspersed, creating a hybrid and "epileptic" viewing experience. Courtesy of Paul Sharits Estate and Christopher Sharits.



that inspired them, the only evidence remaining—a lamp left burning, a door left open, and a patio light left on—are fragments without a whole.

Similarly, *Mod Lang* (2001), *Berkshire Fangs* (2001), and *Chemical Sundown* (2001) depict fragments of a pseudo-narrative and tracings of a partial world. Things are disguised and situations obscured, often by bold shapes and abstract colors. Visual clues point to the story, but ultimately end up indicating that much more remains unknown. Taking its title from the legendary Memphis pop group Big Star, *Mod Lang* focuses on the protagonist, Keith "Slick" Rhoades, a rebellious character "in the mold of Quadrophenia's Jimmy Cooper" who em-
7.11 barks on a three-part epic. Rhoades moves to LA, meets a girl, and encounters drugs. He "loses control of his scooter on a rainy English road one night" and suffers neurological damage, but nonetheless the "refractory Mod finds his true calling: as a visionary architect whose building schemes bring him fame and fortune while providing a grand opportunity to antagonize conventional propriety."[22] The Slick Rhoades story *in-forms* its clean modernist shapes and colors. On their own the abstractions bear little signification. Below I argue that this process instantiates Katherine Hayles' concept of "information narratives," but for the moment I must stay with Blake's technique of straddling back and forth between color and narrative. By actively obscuring meaning, but simultaneously *pointing to its absence*, Blake introduces a kind of pseudo-mysticism and ghostly presence in the work, not quite there but somehow indicated in its absence, through colors as they become expressive in and of themselves, liberated from narrative and form.

Complementing the narrative fragments, one finds partial images and partial objects shifting between total abstraction and representation. *Angel Dust* (2001) depicts abstract shapes rapidly sliding on- and offscreen. Organized on a grid, the squares occupy the entire screen and consist of about seventy-five layers of colored squares, some shifting hues, others remaining static, alluding to "techniques inherited from traditional painting (i.e. using layer upon layer of translucent color)."[23] Moreover, while the images point to abstraction, the title *Angel Dust* connotes a particular chemical substance, culture, and historical moment. *Angel Dust* or PCP (phencyclidine) is a hallucinogenic drug that induces forms of neurosis and disorientation. As Blake explains, *Angel Dust* is a "hallucinatory treatment of an imaginary ski-lodge." But in terms of the colors and images themselves, one is not given this sense within the work. Designer drugs, like designer color, are compact and compressed products that necessarily obfuscate their origin and contents. Similarly, in *Guccinam* (2001) and *Station to Station* series 1–5 (2001), one finds abstract gridlike compositions, with dark and rigid shapes that automatically move on tracks like items on a conveyor belt. Colors remain strong but they are restrained, controlled by the formal grid that structures them. And again, meaning is held at bay: references are offered up just as easily as they are taken away.

Where narrative-based feature films tend to rely on clear, realistic photographic imagery—with an occasional gesture toward abstraction—in Blake's work the equation is inverted, particularly in his early work. With Blake, one is always unsure of objects and seldom given the opportunity to infer. In *Liquid Villa* (2001) one may think one recognizes windows on the side of a building, but the perspective is restrained, blocked by a color overlay. In another image from *Berkshire Fangs* (2001), one sees a computer-generated spaceship-like door opening to reveal another partial world behind it, consisting of winding strips of confusing and incomprehensible colored lines; swerving across the screen like cigarette smoke, they dissolve any stable signification. Caught between abstraction and representation, narrative is stopped in each sequence. Time is suspended: pushing forward while encountering blocks at each turn.

Near the end of *Chemical Sundown*, the third installment in the Rhoades trilogy, a photograph of a blond woman in a pink flowing dress appears. Slowly rotating like a plastic figurine on a pedestal, she is animated in a stilted fashion, like a frozen icon on display in a shop window. Despite this brief appearance (one of the rare photographic appearances in the early works), the underlying sense is still that *sense itself* is withheld. The girl exists, but remains anonymous and unknown. The description (once again) fills us in: Slick has been "exiled to the lush apocalyptic dreamscape of Southern California," where he has built his own "pleasure dome in the Los Angeles hills [and is] now living large with a beautiful sad-faced girl."[24]

7.11 Jeremy Blake, *Bungalow 8: Black Swan* (left) and *Bungalow 8: Hotel Safe* (right), both 1998. Sequence from digital animation, 3 minute continuous. Courtesy of Kinz + Tillou Fine Art.

Around the time that Blake produced the *Punch Drunk Love* sequence for Anderson, who requested an upbeat version of *Winchester* suitable for conventional film, a shift occurred.[25] In the work made after 2001–2, Blake's colorism is marked by more fluid and luminescent colors; more narrative inclusion, voiceover, and an abundance of cultural signifiers. The geometric colors in the early pieces make clear allusions to various modern colorists like Piet Mondrian, Kazimir Malevich, Ellsworth Kelly, and François Morellet. In the middle works, one finds references moving backwards in time, to German Expressionism and Impressionism in the nineteenth century (such as J. M. W. Turner and Claude Monet). In the late work Blake becomes increasingly concerned with narrative, returning to the origins of Western art and the Renaissance's classification of the image as a "visual narrative." At the same time, colorism in this late work begins to resemble the hand tinting, dying, and coloring techniques used in silent film. When viewed from beginning to end, Blake's work *inversely* reflects the histories of color in painting and film.

Given these three variations of color in relation to narrative, and Blake's growing aptitude in mobilizing the third, we may now align his color treatment with Katherine Hayles' concept of the "information narrative." Emerging from computer culture, the information narrative denotes a shift in storytelling from the emphasis on presence and absence theorized in older media to the tropes of *pattern* and *randomness*. In the information society, Hayles argues, "pattern *is* the essential reality" from which subjectivity is born.[26] Blake's images and convoluted story lines oscillate between fragmented patterns and traditional modes of storytelling. The technique echoes what Vilém Flusser refers to as "post-history" or a "post-historical" situation comprised of technical images (see chapter 6) which navigate the tension between a preprogrammed reality and the increasingly narrow possibilities for its rupture, randomness, or malfunction. Similarly, Blake's images and convoluted storylines oscillate between these preprogrammed patterns of traditional modes of storytelling and ruptures that invoke distortion and noise in the form of color; color as meaningless affect and effect.[27]

In other words, Blake's style is neither pure noise (randomness) but instead a kind of disinterested stylistic distortion; a half-pattern formation constituting what Friedrich Kittler informally dubs an "aesthetics of interference" (which must be seen as antithetical to "information aesthetics," as I discussed in chapter 3). An aesthetic of interference allows noise and abstraction to figure as stylistic motifs *intentionally* fed back into a signal, data flow, or image to generate a sustained pattern of interference. It is the mobilization of what Flusser terms the "malfunction" in the "program" as an aesthetic trope.[28] In Blake, such interference aesthetics appear in the form of thick patches of opaque color, mixed in with his use of photographic imagery and textual signifiers, carefully

modulated through his use of pseudo-narrative. On the one hand then, these patterns become noise—meaningless to a viewer's eyes and ears—but on the other hand, it is precisely because of this ongoing play between pattern (meaning) and noise (interference) that Blake's images figure as accurate reflections of hyperdividuation in media culture. This is how and why Blake's colorism is markedly digital and informatic, in terms of style, material technique, and ontology.

Layering: History at a Standstill

Blake has used visual layers from the start—whether by mixing media like photography and painting, text and image, or the layers of history itself. Where older methods like silkscreen or offset printing involved time-consuming rituals to separate and maintain the color identity between each CMYK (cyan, magenta, yellow, black) layer, digital media have radically simplified this process. Photoshop software is known for its flexible layers and color channels. In fact a "mask" in Photoshop is only a more sophisticated alpha channel (see chapter 5 for more on the alpha channel). When Photoshop was introduced in 1990, it integrated features for increased automation, efficiency, and digitization, allowing users to layer elements, vary degrees of transparency, and manipulate objects and colors independently of the rest of the image with flexibility and ease.

Layering aesthetics are closely associated with techniques of montage and compositing (chapter 5), which have historically tended toward one of two extremes. On the one hand there is a practical use of layers: a newspaper uses different layers of images, text, and captions and blends them into one seamless, flat image space. On the other hand, there are layering techniques that make the layers explicit, such as Paper Rad's dirt style, or John Heartfield's collages, which accentuate the *disjuncture between image elements*. These two styles may also be extended to politics: the former figures as an ideological covering over, while the latter figures as critique, revealing the inner workings of the "apparatus." However, capitalism is increasingly quick to appropriate any critical practice into a cultural dominant, as Raymond Williams has noted. So while Blake's compositions reveal fragmentation in their layers, this alone does not guarantee critique. Without an accompanying analysis, fragmentation and layering in themselves reveal nothing. Furthermore, Blake's layering technique—like Paper Rad's—connote disjuncture and fragmentation in *human* experience—not ideology critique. In short, the technique is indicative of a condition, not a criticality.

In his early work, as noted, Blake seamlessly merges and subtly blends layers. From *Bungalow 8* (1998) to *Liquid Villa* (2001), *Angel Dust* (2001), and *Station to Station* (2001) the layers (subject to the same color treatment) almost always blend together in what resembles a formalist composition, consistently

involving smooth animations of fairly rigid, clean geometric shapes. At the same time, another technique begins to develop with *Chemical Sundown* (2001), *Winchester* (2002), *1906* (2003), *Century 21* (2004), and *Sodium Fox* (2005). Here, layers start to function as aesthetic objects, left open to reveal dirt and disjuncture. These layers display difference *as difference*, whether in content, style, reference, or origin. For example, at the end of *Chemical Sundown*, the juxtaposition between photographic and opaque color proudly announces itself with the rare appearance of a human figure. Framed within a frame, the "beautiful sad-faced girl" slowly grows larger on screen. However, as noted, the photograph remains frozen and the girl appears immobile. As the image is enlarged, the smooth animation seems to thaw her out, bringing her back to life in extended slow motion. The juxtaposition between human figure and abstract, saturated colors intensify the disjuncture of time unfolding out of time.

In *Reading Ossie Clark* (2003), soft and luminous rainbow colors ooze over the mouth of a static, desaturated photograph of a woman's face. In *Winchester*, the same rainbow ooze emanates from a vintage photograph of a cowboy's forehead after receiving a bullet of opaque light. Contrasted with the rigid geometric color in the earlier work, this oozing, drippy paint is more luminescent, but also messier. Subsequently, the unclear luminous layers introduce a *conceptual block into material meaning*. In other words, the relationship between visual and semiotic elements renders a visceral materiality to the color that denies base matter, such as a house or car, favoring instead a *materiality that is transcendental*. One begins with luminous opaque colors on the surface layer—a symbol of elevation that points beyond the image—but does not and cannot move beyond it. Embodying matter and spirit in one, colors free themselves just as they remain limited to the canvas (or screen). This is echoed as bits of representational imagery invite cognitive and intellectual engagement, but color abstractions keep them at bay. The doubling movement within the colored layers in relation to other layers (versus narrative development) returns representation to the material and technical ground of the screen and image. Color moves simultaneously in two opposing directions, leaving one in a conceptual and visual standstill.

History at a standstill emerges from these preconditions. The temporal instant of a no-time time depicted throughout these "time-based" artworks is, as Rolf Tiedemann has argued elsewhere, a gesture to regain experience, consciousness, and essential meanings, but one that ultimately fails to do so.[29] Acknowledgment of this failure allows formerly sacred color to become profane: leaving only the specters of presence in the noise of a muddled and confused human history. Blake's semitransparent layers visualize this ambivalence. Furthermore, the ontology of the standstill—a no-place place caught in dead, cyclical time—is also evidenced in his treatment of history as a medium of radical mediation, and epistemological (mis)perception.

Spirits and ghosts symbolize the failure of progress narratives, coupled with the inability to see or comprehend history, as such. During the nineteenth century, in an attempted reconciliation for earlier violence, Sarah Winchester, heiress to the Winchester gun fortune, boarded up portions of her California mansion in order to, she believed, protect it from its haunted past. The *Winchester Trilogy* (2002–4) opens with *Winchester* (2002), and an aerial view of the Winchester mansion accompanied by the sound of a rotating film projector. Philip Monk observes how the juxtaposition between cinema and the mansion creates a "proto-cinematic haunting machine"[30] that aligns the history of the West with the history of early American film: both are obsolete and yet they remain actively haunted by vital and animated spirits.

The next piece in the trilogy is *1906* (2003) and the third, *Century 21* (2004), which opens with a neon Century 21 sign perched on top of a movie theater, alluding to the new movie complexes and developments that mark the changing landscape of California. Where the Winchester mansion was once built over Native American lands, today multiplexes and California McMansions layer over nineteenth-century architecture and ghosts of the "wild west." The three parts of the trilogy add historical reference upon reference—layer upon layer—making any single image disjunctive and ambivalent (figure 7.12). While I discussed the disjoined layering aesthetic of color and photographic imagery above, here the juxtaposition is historical, creating a future push and backwards pull within each layered composite. The effect echoes Jameson's notion of postmodern pastiche, where historical eras blend in an indecipherable present without origin, certainty, or singularity. Instead of intensifying narrative as a form of narrative saturation, as discussed above, colors here grow, becoming more alive: literally animated to draw in the specters and paradoxes of history into the present.

The intentionally odd mix of past, future, and present, ghosts, machines, and reality, and opacity and transparency in the *Winchester Trilogy* crosses temporal and existential boundaries, allowing spirits to materialize and historical fact to evanesce. As ghosts are memorialized they become objective and eternal, while houses, theatres, industries and people fade into distant memory. Even the drug-induced psychosis in *Sodium Fox* shows how Blake's "subjects" consistently reflect a cloudy experience in the present. But if ghosts (and by default opaque color) have become more real than reality, and the stories that they supposedly derive from, then these unruly digital color effects must be understood as a viable framework to analyze representation, subjectivity, and historicism today.

The significance of the disjunctive-layering aesthetic in Blake's work—versus the seamless blending of layers—must also be positioned against the conventional arguments for "remediation" and "remix culture" (and in this regard his work is also stylistically analogous to Paper Rad's, as analyzed in

7.12

chapter 5). For David Jay Bolter and Richard Grusin, "remediation" entails the loss of media specificity into "hypermedia." For Lev Manovich, the release of After Effects in 1993, complementing the release of Illustrator and Photoshop a few years prior, introduced a hybrid or "velvet revolution" in software, where products and applications meant for different industries or output platforms could be used interchangeably, resulting in what he terms an "aesthetics of continuity," characterized by an aesthetic of seamlessness that recombines different elements into a unified whole.[31] As he puts it elsewhere, "To use the terms of Roland Barthes, we can say that if modernist collage always involved a 'clash' of elements, electronic and software collage also allows for 'blend,'" that is, a "velvet" smoothness to congeal formerly "disparate elements."[32] At the same time, Manovich also recognizes that hybrid media may result in different uses and styles: "In some cases, the juxtaposition of different media is clearly visible . . . In other cases, a sequence may move between different media so quickly that the shifts are barely noticeable."[33] And indeed, one cannot assume that the fact of hybrid software guarantees an aesthetic of continuity, especially in regards to dirt style and Blake's later work.

This is the case, first, because the aesthetics of the unified whole is apropos to Modernist aesthetics, not to Blake's work or dirt style which are more in line with poststructuralist and postmodern sensibilities. This also includes colorism in the service of remix, mashup, and glitch art, all of which intentionally and provocatively leave the seams open and on display. Second, the aesthetics of continuity prioritizes cohesive narratives and a unified compositional structure that is far from progressive, but rather a relapse into the ideology of chromophobia, which privileges *disegno* (form, order, narrative) over color and sensation. Glossing over the ways in which the latter terms have been subordinate to form and Reason, denies the significance of Blake's colorist interventions in the history of Western aesthetics. Moreover, if one fails to take account of the continual and ongoing disjunction, intentional fragmentation, resistance to hermeneutics, and standstill in Blake's work, one misses a critical entry point for understanding his work, and by extension the way it in which it corresponds to the new paradigm of colorism in digital art.

With Blake, as with my analysis of Paper Rad in chapter 5 or Jordan Crandall in chapter 6, it is through color, layering, and abstraction that the gap between cognition and sensation, or code and interface, is rendered in critical and aesthetic form. Using the same color grading techniques pervasive in industry and feature films, Blake pushes digital color to the edge of representation, to the extreme of style, which in turn brings about a visualization not of digital code per se, but rather the way in which the *logic* of the algorithm structures and sets the conditions of possibility for *all* visual style, as such. Before concluding, I want to note three works that demonstrate how Blake's use of fragmented voiceover narration complements his color treatment.

7.12 Jeremy Blake, *Winchester*, 2002. Sequence from digital animation, 18 minute continuous. Thick patches of colors overlay each other, creating a rich and textured compositional space. Courtesy of Kinz + Tillou Fine Art.

Sound holds an intimate relation to the moving image, a relation that has been theorized since optical sound was introduced in 1927. However, much less has been noted about the role of voiceover narration, perhaps because voiceover narration is often used when the budget cannot accommodate the synching of sound and image. Regardless, voiceovers play a curious role in Blake's late work. After *Reading Ossie Clark* (2003), voiceover narration is constant in his last two pieces: *Sodium Fox* (2005) narrated by a "reclusive and profoundly talented poet named David Berman," and *Glitterbest* (2007), left unfinished at the time of Blake's death, but nonetheless narrated by punk-rock icon Malcolm McLaren. While it is believed that much of *Glitterbest* was in place at the time of Blake's death, one cannot know how it might have looked had he finished it.[34] The found files consisted of several Photoshop layers. McLaren's voiceover, already complete, like that in *Ossie*, contained fragments of references: to "Blitzkrieg yellow, Minnie Mouse pink, England's pastures green, bullocks blue . . . grandmother rose . . . lush . . . lip-gloss only . . . punk." These color-coded phrases seem to want to connect to a larger whole, to use color to index history or memory, but they cannot—they remain stilted, frozen, and incapable.

Similarly, *Sodium Fox* opens with a still image of a bikini-clad girl lying in the sun. The "camera" scans the image like eyes grazing a body. Berman announces, "Cross-eyed from giving too much head . . . she leaves her makeup beside a mountain of clothes . . . tonight God has asked her to love me as a favor to him . . . [thunder]." The image transitions to a view of the sky—possibly the stars seen through a skylight—and a man with opaque yellow rays coming from his eyes appears wearing a helmet. One is not sure who is talking, if he is talking about the girl on the screen, himself, or if he is being literal or metaphoric, or both. Aural confusion echoes visual confusion. The sound track consists of fragments of Berman's poetry, arranged in sonic patterns and phrases without a throughline. In *Sodium Fox*, Blake took James Rosenquist, Neil Young, and Jean-Luc Godard's *Alphaville* as inspirations for the treatment of his narrator's "interiority as a landscape."[35] The sonic mixed messages not only depict the subject's internal reality in spatial and visual terms, but in so doing intensify the mismatched historical patterns already under way; a voiceover narration that saturates its own incapacity to narrate.

Reading Ossie Clark is a literal reading of the journals of the late fashion icon Ossie Clarke by art critic Clarissa Dalrymple. The piece is also full of rhythmic and half-baked references to car crashes, pills, the "night of a thousand frocks," and unlucky spiders in the bath. "Here smoke this Ossie, we'll have a better day tomorrow," commands an anonymous voice. References to drugs, fashion, life in the fast lane, and suicide remain liminal; bits of information without consequence or context. In many ways, the use of digital color to portray drug use and its related culture here assumes a cynical tenor, antithetical to

the more sincere yet satirical portrayal of color in Paper Rad's work. While one sees photographs of headlights, spilt pills, and collages of body parts, lipstick, and psychedelic colors, they seem alienated and bear little relation to each other. The voiceover fragments refer to the image, but they do so by way of obfuscation and confusion, blocking meaning, thus intensifying the autonomy of color patterns and sensations.

Katherine Hayles has argued that subjectivities in the information narrative become patterns. As long as a pattern endures, a subject has attained "immortality."[36] Blake's images and fragments of voiceover fail to produce causal meaning or unified coherency, but they do provide patterns of effects and visceral textures that transcend the limits of the cognitive and logical and allow history, however muddled or dirty (like dirty color revealing the mediation inherent in modern perception), to live on in the present. The ongoing exchange between the material and immaterial, consciousness and information, and form and color ensure that fragmented patterns and narratives become central motifs. But they are also just that: ongoing and fragmented histories continually suspended in oscillation without any resolution. All constituents remain at a standstill.

Photoshop Heaviness

With Blake's digital coloration techniques in mind, we can now directly address the way in which narrative saturation and layering figure in the Photoshop cinema. The theory of the Photoshop cinema is on the one hand specific to the use of color in Blake, but on the other hand it may be extended to other instances of colorism in digital cinema, such as *Sin City* (2005), *Waking Life* (2001), *300* (2006), *A Scanner Darkly* (2006), *Speed Racer* (2008), and *Sky Captain and the World of Tomorrow* (2004) (figures 7.13 and 7.14) and, as noted, to contemporary digital media aesthetics in general.[37] In this broad sense, the Photoshop cinema is offered as a theory of digital colorism apropos to new media aesthetics in the 2000s, and in particular, as a complementary counterpart to Lev Manovich's 2002 theory of "generation flash."[38]

In his article by the same name, Manovich offers a theory of Internet aesthetics qualified by simple, thin, clean Bauhaus-like lines. He offers this term because the generation of web and graphic design that emerged in the 1990s came to rely increasingly, perhaps even exclusively, on (what was then Macromedia) Flash software to create web products. In contrast to the streamlined contours of the Flash aesthetic, the Photoshop cinema is thick and heavy, and this heaviness has since migrated online.

The Photoshop cinema is heavy first and foremost on a material-technical level. Flash, like Adobe Illustrator, is a vector-based program, where all images are composed of vector sequences. A vector is an image composed of smaller objects, all of which can be defined, or expressed, as mathematical functions,

7.13 such as a line or a curve. While color is assigned to lines in Illustrator, it is a sec-
7.14 ondary concern compared to the program's primary function: to outline shapes and forms. Photoshop, on the other hand, is a bitmap, or raster-based, application where images consist of three layers of pixels. A 16-bit image in Photoshop would have two values for each R, G, or B pixel location (2^{16} = 65,536 colors), so three layers of color value, plus an alpha channel, are assigned to each pixel. This adds up to a lot of information, which means longer processing time, more hard drive space for storage, and more sophisticated display devices needed to see and manipulate the image information.

Even though both vector and bitmap systems produce images with saturated color, the vector-based Illustrator (and Flash, by extension) is primarily concerned with slim and efficient lines, where the bitmapped Photoshop is predominantly concerned with color information. Furthermore, the character of the images produced with each system retains a distinctive look and style. Vector images generate light and clean-looking compositions, like Flash or Illustrator aesthetics, while color photographs labored in Photoshop produce images with multiple layers, which creates a thickness, adds depth, and engenders a more bloated use of computer memory. Between Photoshop and Illustrator, the *disegno* and *colore* debates find their contemporary manifestation.

Second, beyond this material heaviness, there is also an epistemological and historical heaviness that characterizes the Photoshop cinema. As demonstrated in Blake's work, we find layer upon layer of history and culture. With each new layer, the weight of time builds, leaving one suspended in an uncertain visual and cognitive space. Opaque colors double the weight; a visual supplement for what was once *all*-meaningful. Generally speaking, if meaning exists and can be generated from a text or work of art, then interpretation, in the traditional sense of the term, is possible. It is on this edge of possibility that Blake's work thrives. He creates a pseudo-expressionism and indifferent color affect, molded from within already standardized colors and narrative templates.

Blake is by no means the first artist to work this edge between color and form, meaning and non-sense, causality and chance. These binaries date back to the origins of aesthetic theory, and in particular to Kant's discourse on the sublime, which emerged from the backdrop of classical metaphysics, where one saw and knew the world based on the way in which the world revealed itself to oneself. In 1790 Kant inverted this notion so that the subject was now positioned at the center and as the source of knowledge and experience. Known as the Copernican turn in aesthetic philosophy, this radical reversal was Kant's attempt to reexplain the metaphysical gap between subject and object, which came to a heightened pitch in the experience of the aesthetic sublime.

In a sublime moment the subject is overcome by the feeling of awe: pleasure coupled with fear and uncertainty. Reason is unable to come to the rescue and the subject faces an incomprehensible, irreparable gap and void in cognitive experience. The aspect of fear associated with the sublime was first noted by Longinus between the first and third century AD, and later by Edmund Burke in 1756, as a kind of sheer terror of the physical incommensurability and incapacity of the human mind to give representation to the enormous forces and limits of nature. The sublime then, as far as aesthetic experience is concerned, *is* the schism between subjective experience and the objective world, a schism that grows wider through modern science and technics. This ontological and cognitive block is essentially what characterizes the Photoshop cinema.

< **7.13** Dir. Richard Linklater, *A Scanner Darkly*, 2006. Film still. The highly stylized uses of digital color emphasize the thick and opaque aesthetic of the Photoshop cinema.

7.14 Dir. Andy Wachowski and Lana Wachowski, *Speed Racer*, 2008. Film still. Thick patches of opaque color mixed with animation and live action photography characterize the hybrid and rich colorism of the Photoshop cinema.

Considering the sublime in the age hypertechnology, Fredric Jameson argues that these cognitive blocks have been supplemented by late-capitalist, postindustrial, commodity culture. While such postmodern theories have passed their prime, their relevance lingers (if they have not in fact become *more* pertinent, precisely because such criticality draws thin in the current climate). And thus it becomes appropriate to recall that postmodernism, for Jameson, is both a historical period *and* a style, a link that allows him to connect aesthetic sensibilities to historical and critical consciousness.

Where modernism denotes the period in the arts and literature ranging from about 1890 into the early to mid-twentieth century, marked by an aesthetic of "alienation, anomie, solitude, social fragmentation, and isolation" that is linked to industrial mass production, postmodernism emerges in the late 1960s and 1970s and is deeply connected to postindustrial labor and information technology.[39] To highlight this difference, Jameson juxtaposes Heidegger's analysis of Van Gogh's *A Pair of Boots* (1887) with his own analysis of Warhol's *Diamond Dust Shoes*. In Van Gogh's painting, Heidegger recognizes the "world" of the peasant through which one could experience the "authentic" toil of the worker working on the land. The painting moves the viewer beyond its surface by illuminating the whole of the organic, holistic, and unified lifeworld of the worker.

In distinction, postindustrial, postmodern art cannot demand such authentic wholes or self-contained hermeneutics (what I referred to in the previous chapter as "post-hermeneutics"). Warhol's shoes are flat, suggesting an impenetrability and lack of interpretive meaning. Where Van Gogh's colorful gestures were marked by the "stridency of Utopian color," in Warhol and Blake, colors have been inverted as "though the external and colored surface of things—debased and contaminated in advance by their assimilation to glossy advertising images—ha[ve] been stripped away to reveal the deathly black-and-white substratum of the photographic negative." There is no "speaking to us" in Warhol's shoes, just as there is no speaking to us—expression, interiority, or soul speak—in Blake's Photoshop colors.[40] Digital colorism is not concerned with or capable of such internal, visionary imaginings, let alone connecting to a broader utopia or cosmos that once seemed so tangible and concrete, whether in nineteenth-century painting or in the electric artwork circa 1969 (see chapters 1 through 4).

Not only are we no longer able to access this sublime, we are also undisturbed and untroubled by this inaptitude. Commodity culture both engenders and supplements this condition, on the one hand with the fear of automation and hypertechnologies, as discussed in chapter 6, and on the other hand with new promises implied in an ever expanding media landscape saturated with constantly changing, seductive eye-popping hues. In the "cultural turn" to mass consumption, the consumer society, and postindustrialization, the logic of the commodity finally enters all forms of life and experience. What ought to be

powerfully critical in art, Jameson remarks, is now as impotent as any commodity form.[41] Compare the visceral and gut-level corporeal affect in Sharits' depiction of epileptic seizures with Blake's work, where intense color is used not to invoke bodily affect but instead to float above it on the surface, as mere *effect*. This technique similarly applies to a number of the Photoshop cinema films noted above, in chapter 5, and to new works I will introduce in the postscript. Gloss and eye candy dazzle and overwhelm the eyes in rich and flat digital color.[42] The aesthetic of disjunctive layering *and* historical standstill in Blake's work, and by extension in the Photoshop cinema, are symptoms of the way in which digital color in contemporary media art is always already caught in the informatic loops and algorithmic abstractions fueling the postindustrial age.[43]

Electric Cool

All visual, electronic media are cool media. One could argue this thesis was more apropos to analog color television, normative in 1964, when McLuhan formulated the concept:

> There is a basic principle that distinguishes a hot medium like radio from a cool one like the telephone, or a hot medium like the movie from a cool one like TV. A hot medium is one that extends one single sense in "high definition." High definition is the state of being well filled with data. A photograph is, visually, "high definition." A cartoon is "low definition," simply because very little visual information is provided.[44]

With all of our so-called technological progress, one would think that this cool televisual medium had by now become hot. In the last few decades television and screen technologies have dramatically increased resolution and color quality, resulting in various forms of HDTV. Surely this low-fi cool has been overheated?

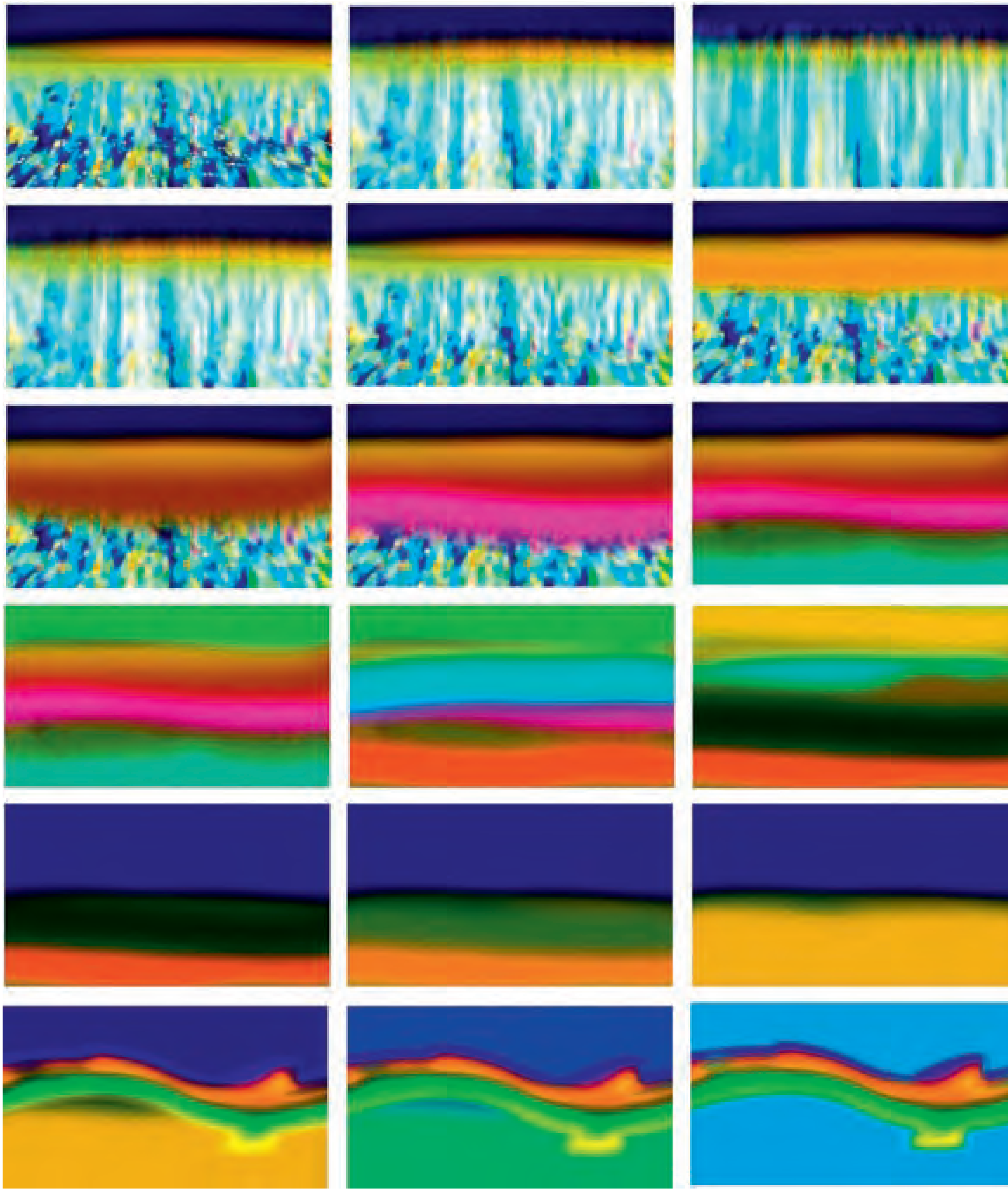
Moreover, McLuhan is careful to point out that hotness and coolness are flexible traits. Using Kenneth Boulding's notion of the "break boundary," which describes the moment when a "system suddenly changes into another or passes some point of no return in its dynamic processes," he explains how a hot medium can become cold by placing it in a foreign culture or through various degrees of technological change. McLuhan refers to this shift as a "reversal of the overheated medium." For example, in reference to urban sprawl, he writes, when "the road [goes] beyond its break boundary [it] turns cities into highways, and the highway proper takes on a continuous urban character."[45] Hot and cool media are like hot and cool affects: fickle, malleable, and adaptive. And thus it must be that television and computer media have, alongside "sophisticated" and "democratic" software, overheated into hot and sexy new toys with high-res candy-colored GUI displays. But in fact television and computer media, I argue, have become even cooler.

Despite improvements in pixel detail, high-resolution screens, or processing amplifiers, electronic media retain a healthy kernel of cool, as McLuhan saw it in the 1960s. First, this is the case on a technical and material level. Both television and computer screens increasingly depend on some form of liquid crystal, light-emitting diode or plasma to generate an image that, as I argue in chapter 2, has a flat and cold character. This flatness is further amplified by the necessary dependence on additive color mixing in viewing electronic imagery, which is to say, an increased involvement in viewing, demanding one work harder to see more of what is already less (i.e., its low resolution and compressed color palette). Then there is the fact that all visual electronic media are overwhelmingly dominated by cool blue or green hues. Video sensors, for instance, are modeled after the human eye, which is far more receptive to value differences in green light than in red or blue—though blue is a close second—which means that bluish or greenish electronic images are much easier, more efficient, and therefore cheaper to produce than red or fuchsia ones.

Computational miniaturization, thanks to the integrated circuit and silicon chip, has further cooled what was already cold. Changes in cinematic viewing conditions also support this shift: watching movies in video versus film, at home on a television monitor, on the computer, online, on a small screen, on airplanes, or at the gym. All of these practices demand increased involvement, participation, and interactivity. Together, these experiences of electronic color give us the very definition of McLuhan's cool media, further enhanced by requirements for "interactivity" intrinsic to new media, making them even cooler than digital television. In sum, coolness resists detail (technically) and emotionalism (stylistically). Its function is to undo comprehensive visual clarity. Cool, as Alan Liu puts it, is an "aporia of information . . . information designed to resist information."[46]

Chemical Sundown

I conclude this chapter with an example from *Chemical Sundown*, where layers of fluid and ephemeral colors continue to play games with history and perception. In a final scene, rigid horizontal lines morph into a series of orange, purple, and yellow waves that loosely represent the chemical colors of the Hollywood sunset (figure 7.15). The colors become fuzzy and blur into each other, giving way to an aerial view of Los Angeles and the darkness that falls after sundown. In this scene nature is depicted as sublime beauty. But the difficulty is that this beauty is the supposed beauty of chemical and polluted colors. Although digitally enhanced in Photoshop to be more opaque, intense, and luminous, the colors nonetheless echo the foggy colors of the dirty Los Angeles skyline. Chemical beauty is a disturbing and uncertain beauty, a visual beauty graspable in an abstracted image, while also sublime in that it carries the unbearable realities of environmental destruction.



7.15

7.15 Jeremy Blake, *Chemical Sundown*, 2001. Sequence from digital animation, 12 minute continuous. The hazy and polluted Los Angeles skyline depicted at sunset. Courtesy of Kinz + Tillou Fine Art.

The saturated colors of Blake's chemical sky allude to a darkened human existence that may now be compared with the hazy chemical colors of Joseph Mallord William Turner's visual reference to Goethe's cloudy color perception in his *Light and Colour (Goethe's Theory)—The Morning after the Deluge—Moses Writing the Book of Genesis* (1843). Here Turner also used soft and sublime spectral color abstractions that appeared in the polluted atmosphere as a result of coal pollution during the height of the Industrial Revolution, transforming the darkened skies into glowing and luminous color-scapes.[47] One may also include the Impressionist painters, and in particular Monet, who painted the distorted and luminous perception of heavy air, transforming (as Blake did) thick air and the invisible apparatus of perception into a mystical and glowing color space. Like the commodity form that mystically transforms material relations into "metaphysical subtleties and theological niceties,"[48] Blake, Monet, and Turner alike use the cutting-edge color technology of their time (whether mass-produced collapsible-tube oil paints or Photoshop brushes) to transfigure the chemical and industrial world into a sublime and majestic one.

But unlike Monet and Turner, Blake works in the postindustrial climate of computer automation and informatics, with pseudo-narratives, or "information narratives," that do not evolve or "progress" over time, but rather they only ever return to the facticity of their own displacement and uncertainty. When one views Blake's work as a symptom of such social and cultural crises, one sees that these so-called narratives and temporal structures have led us nowhere. In fact, passing time in the Photoshop cinema, a so-called time-based medium, only ever returns us to the surface of our flat hypercolored screens. Through historical and critical analysis, however, as this chapter and the previous ones have shown, these luminous colors can be returned to the material ground of history, aesthetics, and the algorithmic techniques (coding, layering, compositing, juxtaposition, and abstract color effects), once developed in the utopian pursuit to transcend them. This is why colorism in the Photoshop cinema is cool, complacent, and indifferent but also concrete, historical, and vital.

This book began in the 1960s and 1970s, in a visionary moment for color in aesthetic computing. In the twenty-first century this color became cold but convenient and flexible, what I have referred to as democratic, or Photoshop, color. Everywhere these dense and opaque new colors deck the ceilings, floors, and walls of our screen cultures; bolstering a society of hyperdividuation sauced on hysterical and ceaselessly scintillating hues but socially and politically complacent. Void of radical ideals and historical consciousness, save for the occasional retro-mashup satire, the failure of the 1960s utopian imaginary now congeals in the vibrant hues of the Photoshop palette, their eye-popping glossy allure flickering, yet caged within each and every liquid crystal display.[49] In the postscript I offer some further thoughts on this paradoxically bright declension.

Postscript

A New Dark Age

> The New Dark Age . . . is optimistic like New Age views, and also depressing like the Dark Ages.
>
> —Ben Jones, Paper Rad, 2009[1]

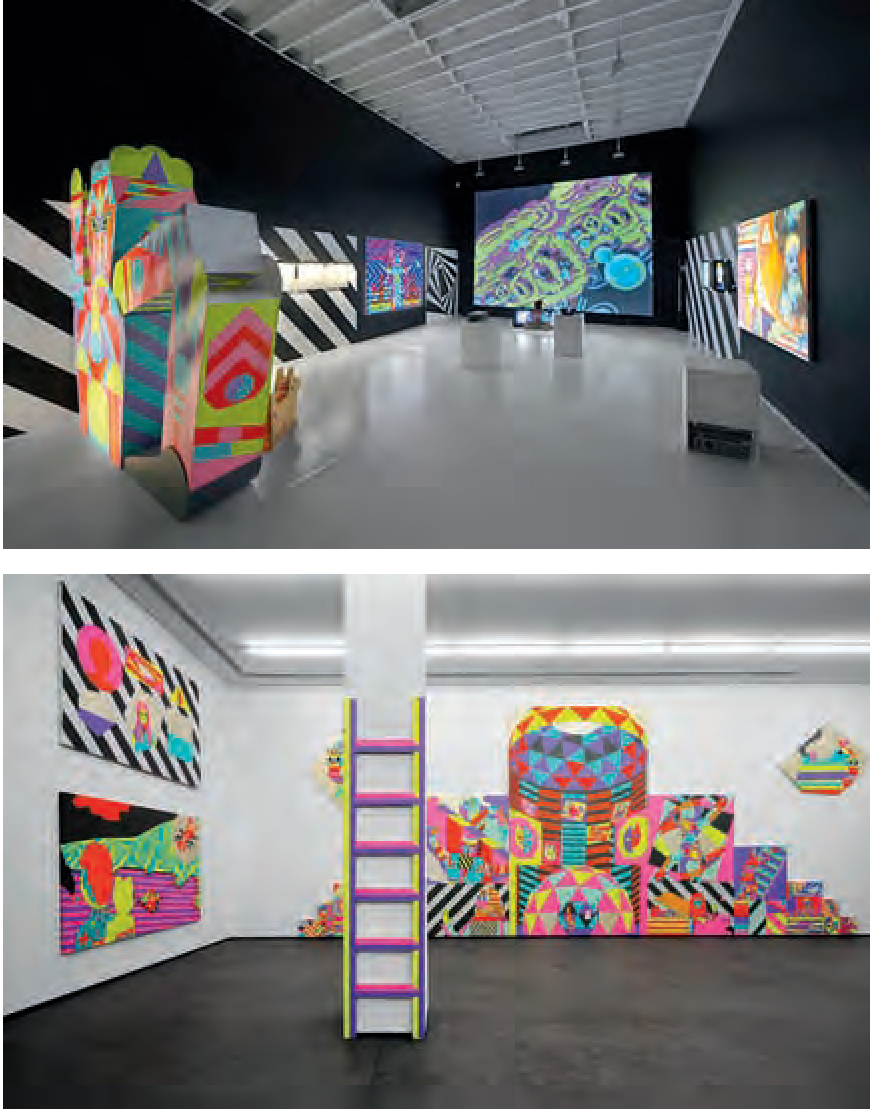
In February 2009, the hip downtown Manhattan gallery Deitch Projects exhibited a brightly colored neon and fluorescent-clad show titled *The New Dark Age* (figure P.1). The exhibition consisted exclusively of the work of interdisciplinary artist Ben Jones, known for his affiliation with Paper Rad, a group of young artists who have been collectively and individually producing various mixed-media artworks, including drawings, paintings, videos, cardboard cutouts, music, zines, and net art throughout the 2000s. As I note in chapter 5, their work is easily identified by their consistent use of bright electronic and fluorescent colors.[2]

The New Dark Age, according to Jones, features five key components, all of "equal importance": fluorescent "ladders" taped to the wall; "minimalism" (in design); "cartoon drawings" (featured in all of the videos and paintings); "dogs" (featured prominently in the images and animations, complemented by a fluorescent doghouse); and "bricks" (used to build the doghouse).[3] He explains:

> My work literally is about 3 color neon ladders, bricks and minimalist dogs. Why? It has to do with taking what the artists of the last generation did, and then doing something slightly different. Then it also has to do with mystical gut dreams that pop in and out of focus when I wake up or sit up too fast. I have visions and ideas that I think are both behind the curtain sneak pe[e]ks of reality and simple human responses to our world.[4]

Both "mystical gut dreams" and "artists of the last generation" signify a slew of predecessors in pop, punk, and the psychedelic 1960s. In addition to the psychedelic works discussed in chapters 1 through 4, I want to consider op artist Peter Sedgley's *Video Disque ROB* (1968) as another work from this "last generation."

Video Disque ROB consists of brilliantly colored concentric circular discs painted to depict the iris of a human eye (figure P.2). Sedgley used fluorescent Sericol paints for the discs, which he then set into a spinning motion under an ultraviolet light to intensify the luminous and fluorescing effects. Fluorescing is also the only way humans can see ultraviolet rays, through a transformative process involving the absorption and conversion of ultraviolet rays into visible color.[5] Under normal lighting conditions fluorescent colors appear brighter than other colors do, but under black lights, or after exposure to sunlight, which naturally contains ultraviolet rays, they pop and sizzle like no other colors can. *Video Disque ROB* forges a merger between the open eye one uses to see color and light and the "third eye" of mystical inner visions. Such luminous and cosmic effects were frequently used in the 1960s, as I discussed in chapter 1, in head shops lining Haight Street in San Francisco, in light art in the 1950s (such as Frank Malina's light-based artwork), and before that in the black light mural installations in grand movie theaters in the late 1930s and 1940s. When Jones picked up this technique in 2009 for *The New Dark Age* exhibition,

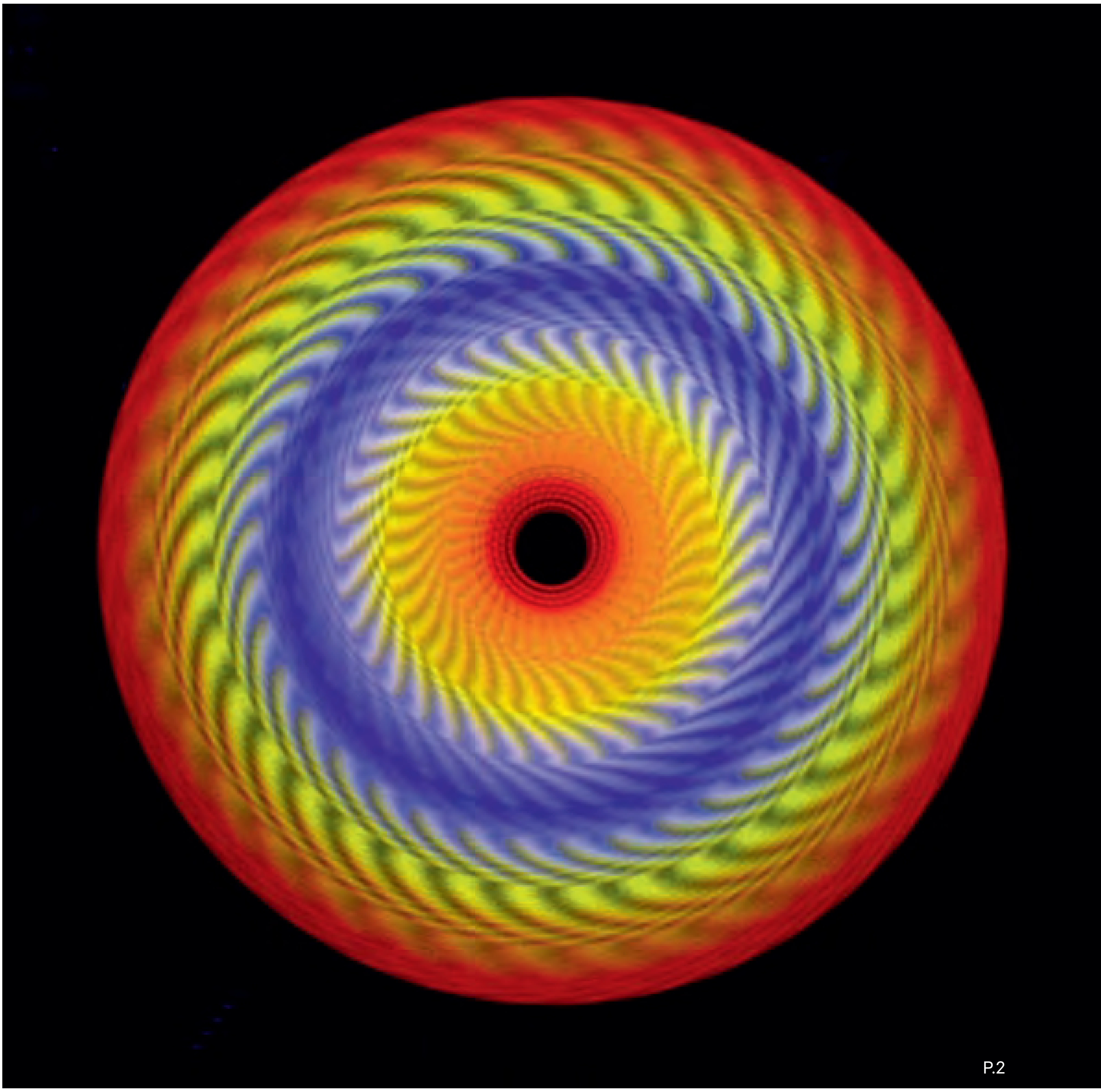


P.1

however, he did so in way specific to his cultural moment and the new paradigm of digital colorism appropriate to it, as introduced in the last chapter.

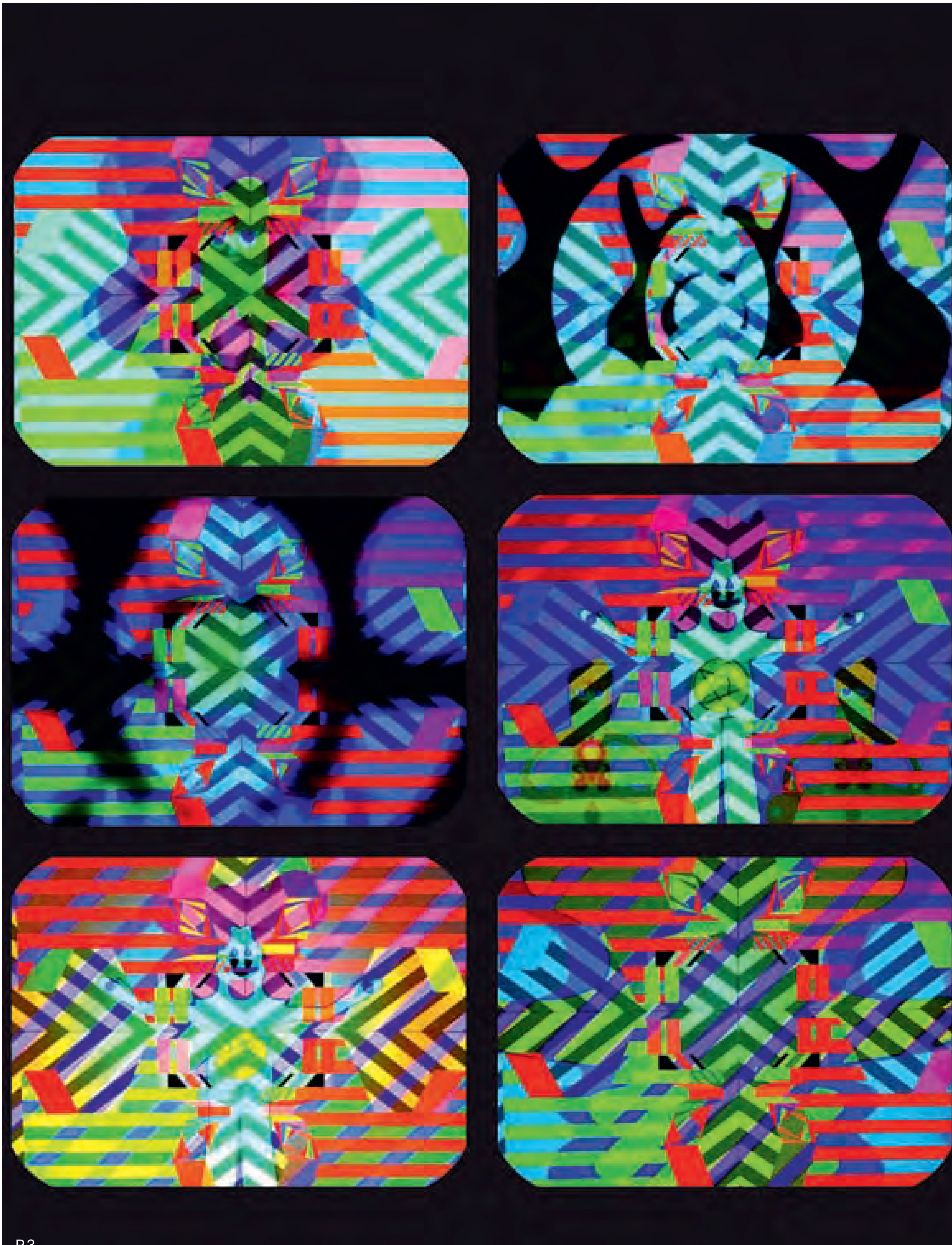
For two pieces in *The New Dark Age*, Jones began by painting two white rectangles on a black wall in the gallery and then painting fluorescent shapes and designs inside them. Two video streams were then projected onto these spaces, which, in the otherwise darkened gallery, make the fluorescent hues pop and sizzle (figure P.3). Underneath the video's light stream the fluorescent pigments were not in themselves apparent, so that when one looked at the installation, it appeared as if the video colors were sizzling in a way that video is typically incapable of. Granted Jones was not using ultraviolet light, as Sedgley was; the fluorescing effect was nonetheless stunning. But the question remains: how could such luminous colors, brighter and bolder than all other electronic colors, be featured in a show titled *The New Dark Age*?

The key to answering this lies in a historical understanding of the differences between synthetic color in new media art circa 1969 and 2009. In this postscript I explore these differences, first through an analysis of fluorescents in bio art, genetic engineering, and transgenics, and second, through a comparison between these benchmark dates—1969 and 2009—which are by no means definitive cutoff points but rather loose thematic markers I use to map out a general shift in the development of contemporary aesthetics.


P.2

< **P.1** "The New Dark Age," installation views from Deitch Projects, New York City, 2009, and "Celebrate The New Dark Age," Andreas Melas Presents, Athens, Greece, 2008. These two fluorescent-clad exhibitions consist exclusively of the work of interdisciplinary artist Ben Jones of the Paper Rad Collective. Courtesy of Ben Jones.

P.2 Peter Sedgley, *Video Disque ROB* (1969). A spinning fluorescent image of programmed elements that, when illuminated with ultraviolet light, appear as a series of brilliant colored rings rotating at varying speeds and in opposing directions. The psychedelic movement alludes to inner visions and the cultural imaginary circa 1969. Courtesy of the artist.



P.3

GFPs

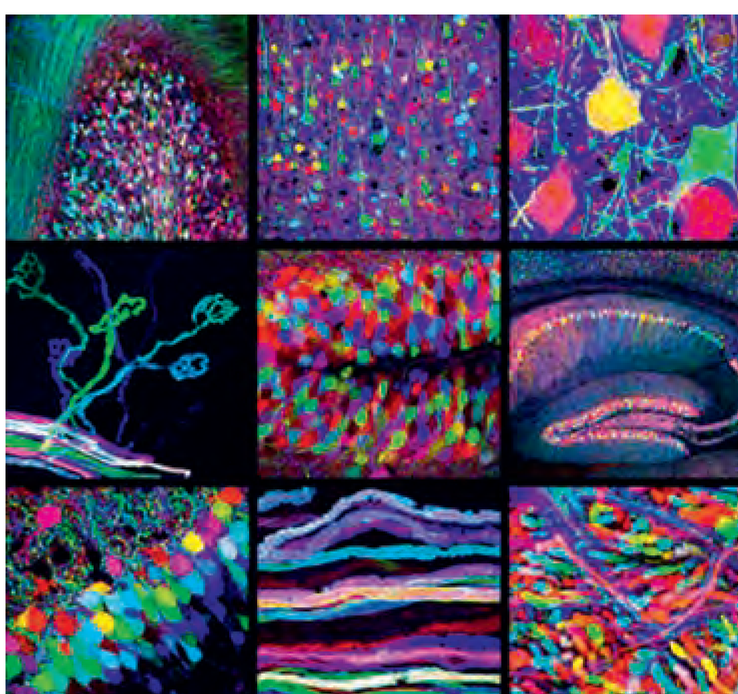
In transgenics (genetic engineering), synthetic fluorescent proteins have now been coded for scientific and commercial purposes. That is, animals and plants may be engineered to glow in the dark. The *Aequorea* jellyfish is the only known natural species to contain a green fluorescent gene, referred to as the GFP (green fluorescent protein), originally isolated by Osamu Shimomura (figure P.4). In 1985 Douglas Prasher further succeeded in isolating the gene from the species, though at the time cloning copies had to be made "sequence-to-sequence." By 1992 scientists learned to extract the protein from the jellyfish and make it functional in other organisms such as the *C. elegans* (glowworm).[6] Today GFPs are implemented in laboratories all over the world and used in many different species including flatworms, algae, *E. coli*, mice, and pigs. In the early 2000s, multicolored fluorescent proteins were engineered in Singapore to sell to American consumers, trademarked as GloFish. At first the transgenic fish glowed only in pink (from coral) but by the time they went on sale across the U.S. (except in California) in December 2003 they could be purchased in three colors—Starfire Red, Electric Green, and Sunburst Orange.[7]

Another use of fluorescent proteins (FPs) is to illuminate live brain cells. Harvard Brain Center researchers Jean Livet, Jeff Lichtman, and Joshua Sanes created multicolored fluorescent brain images of mice neurons, dubbed "brainbows" (figure P.5) When multiple FPs are inserted into live brains and fed through imaging technology, they produce patterns in up to ninety different fluorescent colors. The brainbows are strangely reminiscent of pointillism crossed with a kind of techno-fauvism, though Livet likens the images more to remix and generative aesthetics. The snippets of DNA used to assemble the brainbows, he explains, involved a "cut-and-paste recombination [that] occur[s] totally at random." Different colors are assigned to different neurons so the "technique drives the cell to switch on fluorescent protein genes in neurons more or less at random . . . . like a slot machine."[8] Colors pop and sizzle like a video game played on the new screen that is the brain. "In the same way that a television monitor mixes red, green, and blue to depict a wide array of colors," Lichtman explains, who is also a professor in the Department of Molecular and Cellular Biology at Harvard, "the combination of three or more fluorescent proteins in neurons can generate many different hues."[9] FPs are now inserted into almost any kind of cell and tracked to disclose the "secrets" of cell life, chart the circuitry of the brain and nervous system, and, one hopes, find cures for AIDS, cancer, and various other ailments.

In 2001, twenty-two-year-old Matthew Nagle (1979–2007) was stabbed in the midst of a chaotic outburst at a Weymouth, Massachusetts fireworks show. He survived, but he was paralyzed from the neck down so that any intended actions initiated in his brain could not be carried out by his body. In 2004 scientists from Cybernetikos Inc. used Nagel as a test case for their

P.3 Ben Jones, *Video Painting 1* from *The New Dark Age*, 2009. A colorful video is projected onto fluorescent pigments painted on a white wall space. Courtesy of Ben Jones.

P.4



P.5

BrainGate Neural Interface System. They inserted FPs in his brain to monitor his neural activity and the intended actions initiated in his thoughts. Nagel was told to watch a red dot move on a screen while the scientists tracked his cognitive processes with a green dot, which Nagel could not see. The computers quickly learned Nagel's neural patterns, and when he was later connected to robotic equipment, the actions he was previously unable to execute could now be completed by the robots. A few weeks later Nagel "progressed to playing *Tetris* with his thoughts."[10] Such applications blatantly reinforce cultural narratives of technoscientific progress.

Bio Art

The controversial bio art of Brazilian artist Eduardo Kac, however, exposes the darker sides of these luminous GFPs. Kac defines bio art, or transgenic art, as a "new art form based on the use of genetic engineering techniques to transfer synthetic genes to an organism or to transfer natural genetic material from one species into another, to create unique living beings." His work has aroused protest from animal rights groups as well as audience members at *Ars Electronica*, especially in 1999 when he proposed to use GFPs to "create a dog with fluorescent fur." His plan involved extracting the jellyfish's GFP and inserting it "into the dog's genome so as to make its fur glow with a green light." Even the "forward-thinking" *Ars Electronica* audience members were left speechless.[11]

Between 1999 and 2001 Kac created several provocative installations using the *Aequorea victoria*'s GFP. In *Genesis* (1999) he translated a sentence from the book of Genesis into Morse code: "Let man have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moves upon the earth." He then converted the Morse code into DNA base pairs according to a conversion principle developed for the work and implanted the resulting designer gene into unspecified bacteria that he placed in a Petri dish under black lights. Online users could control the nutrients delivered to the bacteria by altering the strength of the ultraviolet light source (figure P.6). By giving anonymous users this god-like power, Kac calls attention to the often decontextualized (de-worlded) and at times irresponsible use of genetic engineering to manufacture and control "life."[12]

Similarly, in 2000 Kac hired scientists Louis-Marie Houdebine and Patrick Prunet at the Institut National de la Recherche Agronomique in France to collaborate on his *GFP Bunny* (figure P.7). For this piece an albino rabbit was genetically engineered by combining the GFP from the jellyfish with the eggs (embryo) of a female rabbit. The offspring was a rabbit that glowed green under ultraviolet light. As an implicit critique of the alienation of laboratory animals in science, Kac personified the rabbit by naming her Alba. "Alba must be integrated socially and with great care" he insisted. One must learn to have "appreciation for the

P.4 *Aequorea* jellyfish. One of nature's few sources of fluorescing. The jellyfish has since been used to genetically engineer the green fluorescent protein (GFP).

P.5 When genetically engineered fluorescent proteins are inserted into live brains they produce stunning chromatic arrays dubbed "brainbows" by Harvard researchers.

P.6

emotional and cognitive life of transgenic animals."[13] Kac intended to take Alba home as a family pet, but the French lab would not release the rabbit to him, an unfortunate outcome that nonetheless reinforces his critique.

In *Identity Analysis* (2004), German interdisciplinary artist Helga Griffiths placed ultraviolet black lights in a darkened mirrored room, set to shine upon 4000 clear glass test tubes filled with lime-green fluorescent fluid. Petri dishes filled with the artist's genetic code created a circular pattern on the floor. Like Kac's bio art, *Identity Analysis* depicted the way in which the body in the information age has been reconfigured from the figurative and representational into the codified and scientific. Green fluorescent hues mark, map, and capture life as any information system parses and sorts discrete data.

P.7

In contrast, consider the use of fluorescents and phosphorescents in body art circa 1969. German artist Konrad Lueg's installation *Schattenwand* (1968), for instance, consists of electronic flashes and phosphorescent color on canvas. In the piece, any object or person positioned between the screen and the intermittent flash will remain visible as a shadow on the screen. The work treats the body softly and subtly; it is a noninvasive means to invite the embodied subject into its space, using it to give shape to the piece. In distinction, bio art circa 2009 is aggressive and invasive. In these works, as in the work I discussed in chapter 6, information systems capture and extract an aspect of life—its (genetic) code—and from this abstraction build a new and decontextualized, de-worlded, and simulated visual spectacle.

The violent abstraction of life in the new dark age is also rendered acutely in Iraqi-American artist Wafaa Bilal's performance *...and Counting* (2010). The piece is a twenty-four-hour live tattooing performance designed to commemorate the dead Iraqis and Americans in the war. In the performance Bilal's back is tattooed with the names of Iraqi cities, 5,000 red dots to indicate the dead American soldiers, and 100,000 dots made in invisible ink to represent the official death toll for Iraqis. The dots representing the Iraqi death toll are visible only under ultraviolet light. Like Crandall's work, the body submits all of its visceral fleshiness to the track, which, under black light (or infrared), is reduced to a series of statistics and numbers which, when used critically in artwork, reconstitutes historical context and lived experience.

Circa 2009

Circa 2009, the electronic and fluorescent colors developed on the cutting edge of science, technology, and bio art epitomize this jaded new dark age. Mystical inner visions appear, but not because one is drunk on dreams of a better future or a cosmic beyond but instead because one "sits up too fast," as Jones puts it, or because characters have "been mutated" by the "pop culture machine," as Jacob Ciocci puts it. And like any astute artist, Kac, Jones, and Paper Rad "repackage these visions" in a product both "optimistic and depressing." But regardless, one still wonders how such luminous colors became the trademark for abysmal darkness.

Building on the comparative rationale developed throughout this book, and as pointed to above, the answer is rendered historically. Consider just a few of the events that occurred between 1969 and 2009: the endless escalation of the Vietnam War; the 1971 abstraction of the gold standard, leading to what David Harvey termed "flexible accumulation"; the 1973 oil embargo; the collapse of manufacturing into post-Fordism and postindustrialization; Thatcher and Reagan and the rise of laissez-faire economic policy and neoliberalism alongside the dismantling of systems of social protection; the dawn of what Deleuze

P.6 Eduardo Kac, *Genesis*, 1999. Transgenic work with artist-created bacteria, ultraviolet light, internet, video (detail), edition of 2, dimensions variable. Collection Instituto Valenciano de Arte Moderno (IVAM), Valencia, Spain.

P.7 Eduardo Kac, *GFP Bunny*, 2000. Transgenic artwork. In 2000 Kac hired scientists Louis-Marie Houdebine and Patrick Prunet at the Institut National de la Recherche Agronomique in France to collaborate on *GFP Bunny,* a live fluorescent rabbit named Alba. Courtesy Black Box gallery, Copenhagen.

terms the "society of control"; the commodification of culture in general, i.e., postmodernism or the third and purest form of capitalism, as Jameson puts it; the AIDS epidemic; widespread environmental disasters; social and political disillusionment, disenfranchisement, wage stagnation; the cold war; guerilla war; the overall decline in funding for the arts (the closure of artist-in-residency programs, such as the New Television Workshop, which closed in 1992 or the corporate takeover of Bell Labs in 1984); the militarization of civilian life; the rise of celebrity scandal, drug addiction, and suicide; the mass-marketing of the personal computer; the commercialization and standardization of the Internet: TCP/IP protocols, HTML, web browsers, and "democratic" digital color; the burst of the dot-com bubble in the fall of 2001; a new world order of terrorism that finally reached the U.S. on September 11, 2001; and the global collapse of the stock market in 2008 with its subsequent international recession.

It follows that any artist, just as any person, would be deeply affected by these events and circumstances. "It is a mistake to think that the painter works on a white surface," Deleuze wrote in 1981. The painter "has many things in his head, or around him, or in his studio. Now everything he has in his head or around him is already in the canvas, more or less virtually, more or less actually, before he begins his work."[14] These "things" circa 1969 were turbulent, bold, and explosive, but the era's dreams and visions had a power and force that surpassed and transcended them. Circa 2009 we have many more "things," markedly hypertechnical things in hypercolors that float around in our heads and on our canvases, or more fittingly, on our screens. Cheaper colors, sizzling photographs, billboards, pop culture, posters, television, commercials, video games, "natural" disasters, torture, and unending international war, all of which seem harder to surpass and dream beyond. "Things" today move closer; too close and more pervasive in their progressively rapid colonization of psychic, social, and aesthetic life. Kicked to the curb are the wide-eyed utopian futures and mystical inner visions that once fueled the artistic and cultural imaginary circa 1969.[15] The situation is akin to what Felicity Scott deems a state of "disengagement" characterized by a "postcritical turn" that is both "posttheoretical and postpolitical." If there is any attempt to recuperate the "experimental strategies from the sixties and early seventies," she writes, they are void of "any contestatory dimension." Utopic visions and dreams of social and political progress have been supplanted by indifference and cold play, dependent on an instability of referents that perpetually oscillate between abstraction and capitalist spectacle.[16]

And yet despite all of this, color still grows bolder and stronger. Color carries the transgressive and utopian load, regardless of attempts to isolate, standardize, and codify it. "To want substance in cognition is to want utopia," Adorno wrote in 1966; its "inextinguishable color comes from nonbeing."[17] Over two decades later, the "utopian dreams of television . . . [and] possibility

of travelling to other planets has been fulfilled," and yet, he writes, "insofar as these dreams have been realized, they all operate as though the best things about them had been forgotten—one is not happy about them."[18]

Adorno is correct: circa 2009 we had all of these colorful technological things. One was "free" from the many challenges once faced in the attempt to use color in computer art circa 1969. In order to be a web designer or digital artist circa 2009, one need not be concerned with technical languages or the computation processes occurring in the "backend" of the system, let alone getting special access to or residencies in a lab, research center, or television studio to use rare and expensive equipment. Cheap and cool dirty digital colors dramatically transformed aesthetic production, science, data visualization, and even genetic engineering, all of which resulted in a "freedom" and "liberation"—a utopia it would seem—that paved the way for new forms of "democratic" cultural expression: remix, net art, embedded journalism, blogging, synthetic life, social media, and information aesthetics. But as Adorno indicates, something is still missing.

I propose, however, that this missing something is a different sort of thing than happiness. It is instead something rooted in our humility, or failure rather, which is perhaps the same thing. Implicit in Adorno's second observation is the notion that desired utopias are exclusive to science and technology: "television . . . travelling to other planets, moving faster than sound." This brand of utopianism is characteristic of modernism: pure, clean, and efficient, void of "purely expressive colorfulness and profusion," as Bloch puts it, which is also to say void of dirt, transgression, and those messy ambiguous things like satire, failure, or being human.[19] So what happens if the human, with all of our foibles, shortcomings, and inability to attain utopia in any form, becomes the precondition for utopia, and thus for contemporary aesthetics and everyday experience? Perhaps failure, like technology and color, is in fact the essence of the human? If so then the (utopic) future becomes the "fallen" present, and with it ideals and essences flop back into their material facticity. Instead of the idealized (American) goal of "happiness," something a bit darker and more sinister is at work, but also something liberatory and playful: a lightness in our sheer inability to transcend or progress.

If philosophy begins in disappointment, to paraphrase Simon Critchley, then there is nothing profound or original in the idea of failed utopias; or rather, as I proposed in the introduction, that we fail and fall short *is* our original existential condition.[20] If humans, like color, fail mechanization, digitization, algorithmic programming, and rationalization, then what constitutes "failure" as separate from utopia, I suggest, arises only insofar as we increasingly attempt to define ourselves in *distinction* from these things, processes, equipment, and technologies. For example, consider the stark contrasts between the transcendental utopias circa 1969 where, through art, technology was magically

transformed into something pure and authentically human ("the glowing beauty of man at his most human").[21] Here Sedgley's 1968 *Video Disque ROB* remained luminous and vulnerable with an open eye turned towards the future, linking the human eye to an essence or interior "soul." Similarly, the mind-expanding psychedelic hues produced in the video experiments of Nam June Paik, Eric Siegel, and Stephen Beck circa 1969 used "high technology" (analog video computers) to advance "personal and spiritual growth."[22] There were also the early graphics and experimental color systems created by Stan VanDerBeek, Kenneth Knowlton, and Michael Noll, where open-ended philosophical questions were posed at every turn, as if the future *was* the present; free and up for grabs. While these pioneers and visionaries devoted years to shaping these difficult technologies, they did so within a socially and politically progressive context and as a result, their work was predicated on the potential of what-could-be in thought, in use, and not the reality of what it has since become.

And what has become of these visions and technologies is now clear, but of course, this could not have been known at the time. Instead of mystical color, one has aggressive hypercolors, restricted to a web template of 216. Even German painter Gerhard Richter has used discrete "digital" color in his paintings and installation work. His 2007 Southern Transept Window for the Cologne Cathedral, for instance, places multicolored glass in the gothic structure, but instead of divinely colored imagery of theological figures, as one may expect, he leaves only 11,263 small, randomly generated square elements, reduced to a palette of 72 colors that cannot help but allude to the flat and low-resolution colored graphics of the web. Richter's colors, like the palettes invoked by younger generations of digital artists, speak with a pseudo-objective indifference to the old world's laws and values of transcendental color. In closing, I offer two last examples from Jennifer Steinkamp.[23]

Jennifer Steinkamp's Chromatic Algorithms

California-based new media artist Jennifer Steinkamp offers a luminous yet cynical take on colorism in contemporary digital art.[24] Her *Rapunzel* (2005) consists of a series of six computer-animated video projections of shimmering digital wildflowers (figure P.8). Steinkamp programmed computer algorithms to simulate the elegant movement of flowing human hair, which she then used to generate colored strings of flowing wildflowers on large-scale projections. In allusion to the tale of Rapunzel, the strings of colorful flowers are both tantalizing and sensuous to the eyes. In the classical story, the maiden Rapunzel is betrayed by her parents' inability to resist the seductive flowers growing in the neighbor's yard. The neighbor, a witch, catches Rapunzel's mother stealing the flowers and makes a deal with the couple that permits her to take Rapunzel away and lock her in a tall tower. The flowers figure as that seductive thing

P.8 Jennifer Steinkamp, *Rapunzel*, 2005. Computer algorithms are programmed to simulate the movement of flowing hair in the form of tightly controlled colored flowers. Courtesy of ACME, Los Angeles.

that promises to quench desire but only ends up ensnaring it. This promise of the flowered hair in Steinkamp's *Rapunzel* now appears alone, without a world and isolated against a black wall, which in turn pushes the luminous colors forwards, intensifying their sensory appeal and visual delight but also, by virtue of their ephemeral, simulated, and alienated nature, makes them that much more impossible to grasp.[25]

Steinkamp's *Daisy Bell* (2008) also uses algorithmically generated strands of colorful flowers (figure P.9). The piece takes its name from a nineteenth-century English song, and the way in which it was adopted by Max Mathews (chapter 4) in 1962 at Bell Laboratories to demonstrate the IBM 704 audio synthesizer, later used in Kubrick's *2001*.[26] In *2001*, the supercomputer HAL 9000 begins to sing "daisy" as his consciousness is degraded (foreshadowing darkness in an otherwise optimistic era). In *Daisy Bell* this solemnness is echoed and amplified as a series of luminous flowers coolly cascade down the gallery wall. Their preprogrammed movements leave nothing to spontaneity or chance, or, as flowers would have it, to the wind.[27] Very much unlike the psychedelic colors of Peter Sedgley, Joshua Light Show, Stan VanDerBeek, John Whitney, or others from this era, Steinkamp's colors are cool, rationally controlled, and calculated. But also unlike the classical approach to color outlined in chapter 1 or the rational computer art outlined in chapter 3, this new school of objective cool knows that pure objectivity of any sort is impossible. This is why color in the new dark age plays at and within its own charts and codes. The flowers of *Daisy Bell* and *Rapunzel* tease the eye and hand, simulating desire and a plush Edenic world beyond algorithmic color, but also remains aware that it is always already caught within it.

P.9

Numerous examples of algorithmic color in new media art assume this face of indifference, a flat affect and surface play analyzed in the last few chapters of this book, including the ultra-cool and tight-lipped "digital paintings" made by Jeremy Blake, Jordan Crandall's cold uses of night vision, Eduardo Kac's controversial use of genetic engineering to create a sad and isolated fluorescent green bunny, and Paper Rad's satirical, tongue-in-cheek hypercolor remixes. In this body of work, one finds none of the future-driven spiritualism

or perceptual expansions that epitomized the utopian art of the 1960s. Instead one finds blocks, absences, and lost spirits, painted in thick patches of opaque and impenetrable digital color. Before digital color and its plush, automated software housing, one encountered a healthy anxiety and uncertainty in the yet-to-be. After software, for all its doom and gloom, Blake's "California noir" is thick and rich, but void of the uncertainty and optimism that kept the pioneers of the 1960s on edge, but nonetheless alive and free (or at least operative within a certain notion of freedom).

Today utopia, affective intensity, and transcendence carry negligible currency. What then is to be done and thought for a future? The ability to accept failure and loss must become mere facets of contemporary life and as such, a precondition for any future freedom or semblance thereof. In this way, it is also through this same body of work—the dirty and cheap degraded colors of Jordan Crandall, Jennifer Steinkamp, Wafaa Bilal, Helga Griffiths, Eduardo Kac, Jeremy Blake, Paper Rad, and Ben Jones—that one finds such possibilities, in the form of colorful and satirical pseudo-transcendental trips to nowhere but right here, flickering onscreen for however brief, or prolonged, a hyperchromatic instant.

P.9 Jennifer Steinkamp, *Daisy Bell,* 2008.
Courtesy of Lehmann Maupin, New York.

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Notes

Introduction

1 "Computer art" is a historical term. It denotes a set of uses and practices common in the 1960s and 1970s. It is not a prescription for a particular technique or aesthetic outcome.

2 As Deleuze has noted, a genealogy identifies the origins of a particular set of practices at the same time as it establishes the distance traveled from that origin, denying any possibility of recovering the initial condition, which is to say, the purity of any origin.

3 Deleuze, *Nietzsche and Philosophy*, 3.

4 Jussi Parikka has pointed out that Kittler preferred not to call himself a media archaeologist although others have grouped him into this field. Nonetheless, Kittler's association with the field also highlights the close links between media archaeology and German media theory. Huhtamo and Parikka, *Media Archaeology*, 9; Armitage, "From Discourse," 32–33.

5 Kittler, *Gramophone*, xxxix.

6 Stiegler, *Technics 1*, 41.

7 Stiegler, *Technics 1*, 26, 34. Gille analyzes this apparent possibility of choice as "loose determinism."

8 Wyatt, "Technological Determinism," 168, 176.

9 For a more sophisticated discussion of technics in relation to "prime movers" (causality from within itself) see Stiegler, *Technics and Time 1*, introduction.

10 Flusser, *Into the Universe*, 38.

11 In this way, technological determinism is generally analogous to media specificity. However, by this I do not mean art historical uses of the term that derive from Clement Greenberg's *prescribed* uses for painting. Rather, my use of the term is to a large degree sympathetic with Rosalind Krauss's defense of medium specificity.

12 Peters, "Two Cheers for Technological Determinism."

13 Wiener, "Men, Machines, and the World About," 65.

14 Maxwell observed that a power amplifier or governor could interpret a signal so that when the engine accelerated the steam supply reduced, resulting in a speed or velocity stabilization.

15 Wiener, *Cybernetics*, 11.

16 Wiener, *Cybernetics*, 7.

17 Peters, *Speaking*, 23.

18 Hayles, *Posthuman*, 24. In a sense this is actually incorrect as the presence of noise, glitch, and error in a channel reflects the materiality of the information system.

19 Shannon and Weaver, *Mathematical Theory*, 8.

20 Turner, *From Counterculture*, 22.

21 Peters, *Speaking*, 23.

22 Hayles, *How We Became Posthuman*, 3.

23 Hayles, *How We Became Posthuman*, 3.

24 Hayles, "Cybernetics," 148.

25 Hayles, "Cybernetics," 149, 154.

26 The original name of the Department of Media, Culture, and Communication at New York University was "Media Ecology," coined by founder Neil Postman.

27 Hayles, "Cybernetics," 149, 154; Stiegler, *Technics and Time I*.

28 Wardrip-Fruin, *New Media Reader*, 65.

29 Wardrip-Fruin, *New Media Reader*, 65.

30 Hansen, "Memory," in *Critical Terms*, 65.

31 Husserl, *Crisis*, 109.

32 Heidegger, *Being and Time*, 42. It is in this aspect of a system or "media ecology" that Heidegger's phenomenology can be *loosely* mapped onto cybernetics, as the study of humans and *systems*.

33 Stiegler suggests that Heidegger conflates technicity and inauthenticity because Dasein "falls" to "calculate" the future; trying to "determine the indeterminate," and thus "falling" into "inauthentic temporality." *Technics*, *2*, 6.

34 While there are strands of Kantianism in Heidegger, I cannot go into detail about this here. Generally speaking, Heidegger is highly critical of Kant. Heidegger, *Being and Time*, 73.

35 Merleau-Ponty, *Phenomenology of Perception*, xii.

36 Husserl, *The Crisis of the European Sciences*, 48; Stiegler, *Technics and Time 1*, 2–3.

37 Husserl, *The Crisis of the European Sciences*, 44–45.

38 This thesis can in fact be teased out of Heidegger's philosophy of technology and found quite explicitly in Bernard Stiegler's more recent work.

39 While there are numerous texts one may select for a close reading, therein rendering different and at times ambivalent results, in this brief overview I focus on the essay "The Question Concerning Technology" and parts of *Being and Time*.

40 For Heidegger, *phusis* was the originary condition of being, only later mutated into *physis*. He writes: "In the age of the first and definitive unfolding of Western philosophy among the Greeks, when questioning about beings as such and as a whole received its true inception, beings were called *phusis*" (Heidegger, *Introduction to Metaphysics*, 14). In sum, *physis* is understood to be broadly

analogous to *phusis* (nature) as *alétheia*; the "arising of something from out of itself." For example, in the translation of Heraclitus's *physis kryptesthai philei*, one gets "nature loves to hide." I henceforth use *physis* throughout the text, save for Stiegler's use of *phusis* instead of *physis*. Lovitt in Heidegger, *Question Concerning*, 36.

41 Heidegger, *Question Concerning*, 10, 159.
42 Heidegger, *Question Concerning*, 10, 13, 159.
43 The reference here is to Aristotle's four causes as noted in his *Nicomachean Ethics*.
44 Heidegger, *Question Concerning*, 13.
45 Herein lies Heidegger's sophisticated theory of technological determinism.
46 Heidegger, *Question Concerning*, 14, 21, 171.
47 Heidegger, *Question Concerning*, 14.
48 Heidegger, *Question Concerning*, 15–16, 20.
49 Heidegger, *Question Concerning*, 4, 17, 9, 36, 20.
50 Stiegler, *Technics and Time 1*, ix.
51 Stiegler, *Technics and Time 2*, 1–2.
52 Stiegler, *Technics 1*, 6.
53 Stiegler, *Technics 1*, 4.
54 Stiegler, *Technics and Time 2,* 6.
55 Horn in Winthrop-Young and Horn, "Machine Learning," 477.
56 Barker, "Transformation."
57 Hayles, *How We Think*, 81.
58 Other accounts may focus on different countries and practices during this time. For instance, for a comprehensive account of early British computer art, see Brown et al., *White Heat Cold Logic*.
59 I am referring to McLuhan's theory of hot and cool media, which I return to throughout the book.

Chapter 1

1 Taussig, *What Color Is the Sacred?* 3, 259; Goethe, *Theory of Colours*, 55.
2 Goethe, *Theory of Colours*, 326–29.
3 In the United States, an earlier dye-based "color revolution" began in fashion and textile industries in the 1920s and 1930s. This is noted in more detail below.
4 Albers, *Interaction of Color*, 1.
5 Wiggs, "Color Vision," 9.
6 Wittgenstein, *Remarks on Colour*, 3.
7 Wittgenstein, *Remarks on Colour*, 9.
8 Albers, *Interaction of Color*, 3.
9 Riley, *Color Codes*, 15.
10 It is also possible that Plato followed Heraclitus's early thinking, for whom "Fire is a regulatory principle that is present in the outside world and in our souls." For a more detailed and nuanced history of pre-Socratic and classical theories of color and vision see Zemplén, *The History of Vision*.
11 Color perception for Plato was somewhat of a hybrid affair, though my emphasis here is clearly on his articulation of its internal and subjective aspects. Plato, *The Collected Dialogues*, 45b–c and 54c; my italics.
12 Aristotle, *Aristotle's On the Soul*, 419a.
13 Aristotle, *Minor Works*, 437b–438a.
14 However, it is also important to note that, for the Homeric Greeks (that is, before Plato and Aristotle), "optics" implied a study of light and vision that was both interior and exterior.
15 Zielinski, *Deep Time*, 86.
16 Zielinski, *Deep Time*, 86.
17 Galloway, "What You See."
18 Grant, *Planets, Stars, and Orbs*, 392.
19 Aguilonius, *Opticorum Libri Sex*; Galloway, "What Is a Hermeneutic Light?"
20 A dioptric system, like a computer screen, is either transparent or translucent, on a material-technical level. But as I will show in chapters 4 and 5, this transparent quality is in fact *the opposite* of how the screen operates *on a practical and ideological level*. The screen, as bearer of the interface, makes modern computing *opaque*.
21 While Newton made significant discoveries about light and color before and after this date, his 1704 publication *Opticks* is his most comprehensive and readily accessible work on the subject.
22 Newton also systematically compared color to sound and light waves, indoctrinating the field of color and music analogies, which would develop in the nineteenth and twentieth centuries.
23 This is a general observation concerning Heidegger's overall thesis in *Being and Time*.
24 Lavin, "What Color," 103.
25 Poirier, "Studies on the Concepts of Disegno," 28; Pastoureau, *Black*, 153–54.
26 Kant, *Critique of Pure Reason*, 73–74.
27 Kant, *Critique of Judgment*, 61.
28 See Kane, "Aisthesis."
29 Crary, "Your Colour Memory," 21.
30 Batchelor, *Chromophobia*, 52.
31 Albers, *Interaction of Color*, 150.
32 Plato, *The Republic*, 420c.
33 In the twentieth century, almost all colors, including light-based colors, are considered "dirty" and cheap; I will return to this in section II of this chapter.
34 Batchelor, *Chromophobia*, 23
35 Laruelle, "Of Black Universe," 5.

36 Goethe, *Theory of Colours*, 7, 9, 297.
37 Zielinski, *Deep Time*, 172, 195–96; Wade, *Natural History*, 142.
38 Goethe, *Theory of Colours*, 1.
39 Goethe, *Theory of Colours*, 92.
40 Crary, "Your Colour Memory," 20.
41 Fechner, *Elemente der Psychophysik*, vol. 1, 8.
42 Fechner, *Elemente der Psychophysik*, 9. Fechner also unknowingly rediscovered the phenomenon of subjective perception by spinning a black-and-white top—as Goethe had before him, and Ptolemy before him. Upon discovering the colors that appeared, according to Nicholas Wade, Fechner proudly remarked, "Goethe would have liked the phenomenon since colors be produced from black and white!" Fechner in Wade, *Natural History*, 154.
43 Müller, *Elements of Physiology*, 1162–63; Wade, *Natural History,* 128.
44 Crary, *Techniques of the Observer*, 89; Müller, *The Comparative Physiology of the Visual Sense in Man and the Animals*.
45 Wade, *Helmholtz's Treatise*; Helmholtz, "The Facts in Perception," 86; Wade, *Natural History*, 169.
46 Sherman, *Colour Vision*, 165.
47 Kittler, "Thinking Colours," 42.
48 Two exceptions are Phillip Otto Runge and J. M. W. Turner, both of whom adopted Goethe's color theory into their painting at an early date.
49 For more on Chevreul, see the brilliant work of Laura Kalba, especially "Michel-Eugène Chevreul, Color, and the Dangers of Excessive Variety."
50 Chevreul, *De la loi du contraste simultane*; Kalba, "Michel-Eugène Chevreul."
51 Houston, *Optic Nerve*, 33.
52 Gage, *Color in Art*, 174.
53 Gage, *Color in Art*, 174, 183.
54 Klein, *Coloured Light*, 179. There are numerous color-music systems that predate the nineteenth century.
55 Ostwald's *The Color Primer* was influenced by the work of Ewald Hering and Albert Munsell, two other important color scientists.
56 Albers, *Interaction of Color*, 66.
57 Gage, *Color and Meaning*, 212; Gage, *Color and Culture*, 56; Houston, *Optic Nerve*, 33.
58 As noted, philosophers like Jean-Jacques Rousseau offer similar philosophies, though not in terms of color. I thank Ben Kafka for pointing this out.
59 Hegel, Knox, and Karelis, *Hegel's Introduction to Aesthetics*, 202, 733, 772.
60 Schopenhauer, *On Vision and Colors*, 62.
61 Heidegger, *Basic Writings*, 172.
62 Benjamin, "A Child's View of Colour," 6.
63 Adorno, *Negative Dialectics*, 57.
64 Barthes, *Roland Barthes*, 143.
65 Baudrillard, *Cool Memories*, 55. I thank Alex Galloway for this quote.
66 Melville, "Color Has Not Yet Been Named," 142.
67 For more on this see Wittgenstein, *Remarks on Colour*; Derrida, "The Parergon" in *The Truth in Painting;* and Kane, "Synthetic Color Sense."
68 Adorno, *The Culture Industry*, 103.
69 Barthes, *Camera Lucida*, 81
70 Benjamin, *Arcades Project*, 173.
71 Fuller and Fuller, *Ideas and Integrities*, 180–81.
72 Delamare and Guineau, *Colors*, 16.
73 Grant in Taussig, *What Color*, 144, 148.
74 Delamare and Guineau, *Colors*, 22 and 92. See Taussig, *What Color*, 148, and Kumar, *Indigo Plantations*.
75 Herbert, *Synthetic Rubber*, 32, 37.
76 The BASF Chemical Company, "New Forms"; Kittler, *Optical Media*, 203.
77 Taussig, *What Color*, 218.
78 See Taussig, *What Color* and Andrew, "The Postwar Struggle for Color."
79 Nelson and Bronsil, "Xavier University Research Report"; DayGlo Color Corp., *Designing with Day-Glo Color*.
80 Aristotle, *Minor Works*, 419a1.
81 Youngblood, *Expanded Cinema*, 194.
82 Leslie, *Synthetic Worlds*, 47.
83 Other titles include *Grundlehren der Chemie für jedermann* (G. Reimer, 1843); *Technische Chemie der nützlichsten Metalle für jedermann* (Verl. d. Sander'schen Buchh, 1838–39); and *Die Kunst der Farbenbereitung* (Mittler 1850)
84 Garfield, *Mauve*, 6, 8, 11.
85 Caro also directed the firm that would later become Badische Anilin- und Soda-Fabrik (BASF): Blaszczyk, *The Color Revolution*, 29.
86 Blaszczyk, *The Color Revolution*, 2. The commercialization of these compounds has been explored by a number of historians of the chemical industry. See Beer in bibliography.
87 De Duve, *Pictoral Nominalism*, 148.
88 While coal tar dyes emerged in France and Britain, it was Germany that took the lead in this industry, becoming the world's leader in the mass production and manufacturing of synthetic colors in the 1880s and 1890s. By 1913, Germany held 74 percent of the world's shares in coal tar dye

production. For more details on this see the forthcoming work of Alexander Engel.

89 Beer, "Coal Tar Dye Manufacture," 123; Beer, *The Emergence*.

90 Barton, *The Day-Glo Brothers*.

91 Turner, "Day-Glo Dreams," 2.

92 Barton, *The Day-Glo Brothers*.

93 Day-Glo Corps, *Designing with*.

94 Bing, *The Story of Day-Glo*, 37, and Day-Glo Corps, *Designing with*.

95 Turner, "Day-Glo Dreams," 8.

96 Barton, *The Day-Glo Brothers*; Leslie, *Synthetic Worlds*, 236.

97 Barton, *The Day-Glo Brothers*, 9; Johnston, "Robert Switzer."

98 Nissen, *Germany*, 89.

99 Nissen, *Germany*, 97, 146, 166.

100 Leslie, *Synthetic Worlds*, 186.

101 Turner, "Day-Glo Dreams."

102 "Textiles."

103 "It's Here—New."

104 Dyer, 75–76.

105 Blaszczyk, *American Consumer Society*, part 3.

106 I thank Reggie Blaszczyk for clarifying this chronology of events.

107 While normal spectral colors can "reflect up to 90%" of a color, "fluorescent colors can reflect and emit as much as 200% to 300%!" Day-Glo Corps., *Designing with*, 7.

108 Wolfe, *Electric Kool-Aid*, 26.

109 Gene, *Magic of the Sixties*, 35

110 Gitlin, *The Sixties*, 207.

111 MacFarlane, *Hippie Narrative*, 1; Gitlin, *The Sixties*, 207.

112 Houston, *Optic Nerve*, 74. The exhibition, curated by William Seitz, spawned numerous other international exhibitions such as *Art and Movement* (Glasgow); *Lumiere Mouvement et Optique* (Brussels); *Licht in Bewegung* (Brussels); *Art et Mouvement*: *Art Optique et Cinétique* (Tel Aviv); and Arte Programmata (London).

113 Alison, *Colour After Klein*, 15.

114 Klein, *Yves Klein: A Retrospective*, 220.

115 Braniff Airlines, "The Braniff Pages."

116 "Maidenform's Sea Dream"; Betsey Johnson, cited in Bleikorn, *The Mini-Mod Book*, 83.

117 Leslie, *Synthetic Worlds,* 236.

118 Sabin, *Punk Rock*, 221.

119 Riley, *The Art of Peter Max*, 23. See Riley, *Color Codes*.

120 Rabbit, *Drop City*, 54; Scott, *Architecture*, 198.

121 Jameson, *Postmodernism*, 9.

122 Shafer and Alley, "Overcoming the Problems," 115.

123 Misek, *Chromatic Cinema* 72. Also see Kindem, "The Demise of Kinemacolor."

124 Chisholm, "Red, Blue," 228.

Chapter 2

1 Hays, "Music & Video Feedback," 7.

2 Siegel, cited in Youngblood, *Expanded Cinema*, 314.

3 Siegel, *TV as a Creative Medium*, 8.

4 Youngblood, *Expanded Cinema*, 285.

5 Sandin, Wiseman, and Morton, "A Color Video Collaborative Process."

6 It is important to note that while artists like Nam June Paik produced artwork that directly addressed the mass media, thereby offering another kind of social and political critique, for the purposes of this chapter I focus on his and others' *abstract* video work, therein painting a very particular picture of synthetic electronic color circa 1969.

7 While numerous psychedelic and beautifully colored video artworks could be included in this chapter—such as Scott Bartlett's mystical *Offon* (1967) and *Moon* (1969), made with film and video effects—I focus here exclusively on work made by Eric Siegel, Nam June Paik, and Stephen Beck, pioneers who developed the color synthesizers with which they made their artwork. In turn, an extension of this study would include a more comprehensive analysis of such pioneers as Dan Sandin, Jeff Schier, and the Vasulkas.

8 Small, *The Analogue Alternative*, 30.

9 Manovich, *Language*, 28.

10 Youngblood, *Expanded Cinema*, 257.

11 McLuhan, *Understanding Media*, 54.

12 Paik, "Letter to Radical Software," 3–4 in "Paik-Abe Correspondence." Also quite accurately, in 1979 Paik wrote, "Through the introduction of CCD and 'chip' technology, we [will] soon punch out like doughnuts color cameras without the vidicon tube." Paik, "How to Keep," 4.

13 Lord in Coleman, *Color Television*, 210; "Columbia Broadcasting Exhibits Color," 4.

14 Abramson, *The History of Television*, 22–24; Kittler, *Optical Media*, 222.

15 Chrominance is the frequency of light at any given point on a screen, indicating the saturation or intensity of the color shown. In contrast, the luminance signal determines the intensity or brightness of light at any given spot on the screen.

16 Though it should also be noted that the green portion of the signal was quite important too, as it carried information for the monochrome signal (Sterne and Mulvin, "The Low Acuity.").
17 Ketcham in Coleman, *Color Television*, 31; Sterne and Mulvin, "The Low Acuity."
18 It is also fascinating to note that this claim was made in approximately the same historical moment as the emergence of color television.
19 McLuhan, *Understanding Media*, 22.
20 It is also interesting to note how this tendency to "economize signals" as Sterne puts it, has lent itself to overall history of compression in twentieth-century media that has been largely neglected in visual studies.
21 It took fifteen years to arrive at an agreed-upon standard for color broadcasting (the first NTSC was established in 1940 with a proposal for color accepted in 1947). As Sterne and Mulvin point out, the existing literature characterizes these power plays between industry players (especially between RCA ad CBS) and televisual protocols. For a more comprehensive coverage of these industry debates on color television standardization, see the work of William Boddy, Andreas Fickers, or Gilbert Seldes.
22 Sterne and Mulvin, "The Low Acuity for Blue."
23 Ketcham in Coleman, *Color Television*, 22.
24 Marling, *As Seen on TV*, 328.
25 Ketcham in Coleman, *Color Television*, 24.
26 Polan, personal correspondence.
27 Nielsen in Coleman, *Color Television*, 11; Reitan, *Color Television History*.
28 Misek, *Chromatic Cinema*, 72.
29 Anderson, *Origins of Postmodernity*, 88; Belton, "Digital Cinema," 98; Neale, *Cinema and Technology*, 22.
30 Payne, "Edgy Colour."
31 Siegel, "Patent for the Invention of the Video Color Synthesizer."
32 The manufacturers of LED versions of DLP screens claim a broader color gamut than the LCD color gamut.
33 Payne, "Edgy Colour."
34 For more on these distinctions see Cubitt, "Current Screens," 27.
35 In contrast, in chapters 5 through 7, I show how color in recent digital media art is instead focused on standardization and so-called objective code.
36 Hays, "Image-Creating," 2. Within the category of "video art" there are also several subgenres and styles. There are social and political uses of video, conceptual video art, and more formal or material-technical experiments with video synthesizers.
37 Siedler, "Video Synthesizers."
38 A patch-programmable computer changes or reroutes a signal by means of an exposed panel of interconnected cables. Sandin, "Distribution Religion."
39 Siedler, "Video Synthesizers"; Weibel, *Light Art*, 219.
40 See http://www.vasulka.org/.
41 This is not to suggest that analog is media is somehow retrogressive or less sophisticated than digital media, simply that Vasulka worked ahead of his time in media that were not yet in fashion.
42 Vasulka in Weibel, *Light Art*, 219.
43 Schier, "Nam June Paik," 129.
44 An oscilloscope is an instrument that allows one to observe the constantly varying signal voltages in sound or light. Beck, "Image Processing"; Beck, "Videographics"; Logan, "Unearthing Chicago's Underground"; Andrews, "Pioneering Video Artist."
45 Before turning to color he worked with strobe and solarization effects, developing what he called his "Magic Box." He writes: "it [is] no secret that I was using Mari[j]uana bac[k] then . . . And I noticed that when the TV screen was flickering it was a very interesting phenomena. It was a strobe . . . and this strobing phenomenon was helping to create a trans-like state of mind . . . So I said, this is interesting I want to deliberately play around with this." Linz, "Interview with Eric Siegel," 2–3; Siegel, "Eric Siegel Statement"; Siegel, *TV as a Creative Medium*.
46 Yalkut, "The Electronic Video Synthesizer."
47 Linz, "Interview with Eric Siegel," 4.
48 Vasulka, "EVS."
49 Siegel explains *Einstine* was based on a dream he had that "made a very strong impression" on him, coupled with the fact that he "was using psychedelic substances back then." Siegel in Linz, "Interview with Eric Siegel," 4.
50 Siegel, "Patent for the Invention of the Video Color Synthesizer," 2.
51 Vasulka, "EVS," 120.
52 Schier, "The Eric Siegel EVS Synthesizer."
53 Analog computers function in real time, unlike the pseudo-real time of digital computers. For example, one may move a mouse on one's desk and look to the screen, waiting for the cursor to catch up. The lag time exists because the action is being translated into binary code and this

code is then sent to the processor, which translates it back into a visible result that appears on the screen. In contrast, because analog computers maintain a direct and continuous current between voltages and their modulation on screen, they are literally operating in real time.

54 Schier, "The Eric Siegel EVS Synthesizer"; Yalkut, "The Electronic Video Synthesizer," 1–3.

55 Yalkut, "The Electronic Video Synthesizer," 2.

56 Vasulka in Dunn, *Eigenwelt der Apparate*, 122.

57 Schier, "Stephen C. Beck," 1.

58 It was Brice Howard, director of NCET, who called these luminous color images "direct video."

59 Beck, "A Few Words from Stephen Beck," in Siedler, "Video Synthesizers." Again, this "visual music" genre, while not the focus of the book, nonetheless reappears in chapter 3, in my discussion of the works of John Whitney Sr. and Mary Ellen Bute and again near the end of chapter 4.

60 Beck in Dunn, *Pioneers of Electronic Art,* 123. Both KQED and the NCET were at the time fascinating centers for early video art. For more on this history see Dunn, *Pioneers of Electronic Art*, and Meigh-Andrews, "Pioneering Video Artist."

61 Meigh-Andrews, "Pioneering Video Artist."

62 Beck, "Beck Direct Video Synthesizer."

63 Siedler "Video Synthesizers."

64 Beck, "Video Weavings 1973–1976."

65 Beck, "Video Weavings 1973–1976."

66 Beck, personal correspondence. The patterns in the *Video Weavings* are remarkably similar to Emilio Pucci's designs, both use color to illustrate the automation of a traditional hand technique.

67 Beck, "Video Weavings 1973–1976"; Payne, *Colour Field Film and Video*, 2.

68 Beck, "Beck Direct Video Synthesizer."

69 Video Data Bank, "Eric Siegel."

70 Siegel, cited in Youngblood, *Expanded Cinema*, 314.

71 Crary, "Your Colour Memory."

72 Ruskin, *Elements of Drawing*, 22.

73 Youngblood, *Expanded Cinema*, 316.

74 Hays, "Music & Video Feedback," 7.

75 Heidegger elsewhere makes a clear distinction between *techné* and modern technology, which is further discussed in chapter 3.

76 It should also be noted that both present-at-hand and ready-to-hand often exchange roles. Like "world and earth" they are in a perpetual and ongoing "strife."

77 Harman, *Tool-Being*, 30.

78 Heidegger, *Being and Time*, 102–3.

79 Blattner, *Heidegger's Being and Time*, 58.

80 A similar concept is offered in Deleuze's 1968 explanation of the way in which one learns how to swim. See Deleuze, *Difference and Repetition*.

81 Harman, *Heidegger Explained*, 51–52.

82 Harman, *Tool-Being*, 93.

83 On the other hand it may also be argued that media never die because they always remain in the world, albeit as waste or decay. Dead media are thus zombie media.

84 Anonymous WGBH archivist.

85 Barzyk and Atwood, interview.

86 Barzyk and Atwood, interview.

87 Barzyk and Atwood, interview.

88 Youngblood, *Expanded Cinema*, 306.

89 Paik, *Electronic Opera #1*.

90 Atwood, personal correspondence.

91 Fifield, "The WGBH New Television Workshop," 63.

92 Barzyk and Atwood, interview.

93 Meigh-Andrews, "Video Colour Image Processors." Technically the Wobbulator refers only to the Paik scan modulator, which was distinct from the colorizer and keyer, however, because both were most often attached and used together, I refer to them as one system. Schier, "Nam June Paik," 129.

94 Barzyk and Atwood, interview.

95 Barzyk, "Paik and the Video Synthesizer," 74.

96 Carter, "Without Fear of Failure," 18.

97 Atwood, personal correspondence.

98 Fifield, "The WGBH New Television Workshop," 64.

99 The "Paik-Abe Video Synthesizer," Paik wrote in February 1978, when "officially premiered at WGBH . . . [was] *well below* the broadcast standard . . . It was finally welded into this broadcast standard at Binghamton." "Paik-Abe Correspondence," 40.

100 Atwood, personal correspondence.

101 Barzyk and Atwood, interview.

102 Paik, letter to Michael Rice.

103 Hays, "Image-Creating," 7–8.

104 Hays, "The WGBH Paik-Abe Video Synthesizer."

105 Hays, "The WGBH Paik-Abe Video Synthesizer," 8.

106 Hays, "The WGBH Paik-Abe Video Synthesizer," 10.

107 Benjamin, "The Work of Art in the Age of Technical Reproducibility," 120.

108 Benjamin, "The Work of Art in the Age of Technical Reproducibility," 113.

109 Heidegger, *Question Concerning*, 13.

110 Harman, *Tool-Being*, 185.

111 Personal archives of David Atwood.

112 Ibid.

113 Sieg, "SIGGRAPH 98 History Project." PAL is one of the European equivalents to NTSC.

114 A vidicon camera is a video camera designed with a photoconductor tube.

115 Sieg, "SIGGRAPH 98 History Project." "Sawtooth waveforms" resemble the edge of a saw.

116 Youngblood, *Expanded Cinema*, 200.

117 A two-inch IVC helical analog video recorder is a high-end broadcast-quality recorder; "helical" refers to a method of recording high-frequency signals on magnetic tape.

118 Sieg, "SIGGRAPH 98 History Project"

119 Shoup, "SuperPaint," 37.

120 Sieg, "SIGGRAPH 98 History Project"; Youngblood, *Expanded Cinema*, 200.

121 Sieg, "Analog Computing."

122 Sieg, "Analog Computing."

123 Sieg, "History of Scanimate."

124 Cubitt, "Current Screens," 27.

125 See note 7, chapter 2.

126 Likely lost to twenty-first-century readers is Benjamin's allusion to *Heinrich von Ofterdingen*, an unfinished project written in 1802 by the German Romantic poet Novalis that includes a "mysterious blue flower" as a romantic dream image in the world of technical art.

127 Benjamin, "The Work of Art," 113.

Chapter 3

1 Heidegger, *Basic Writings*, 172.

2 Nake, "The Semiotics Engine." My references to Frieder Nake throughout the chapter are often taken from his unique and valuable personal accounts of this period.

3 John Whitney Sr.'s son, John Whitney Jr., was also involved in early computer graphics, having formed the Motion Picture Products group with Gary Demos in late 1974 and producing motion graphics using his own frame buffer for the feature film *Westworld* (1973).

4 For information on early computer art in other contexts see, Brown et al., *White Heat Cold Logic*; Rosen, *A Little Story*; and Higgins, *Mainframe Experimentalism*.

5 Kant, *Critique of Pure Reason*, 66.

6 Husserl, *The Crises of the European Sciences*, 44–45.

7 Kittler, "Thinking Colours," 41.

8 Plato, *Republic*, 601a–602b. The debates about the role of color (central to painting) as a false and secondary illusion would continue, reaching an apex in the Italian Renaissance's preference for *disegno* (line) over *colore* (color), and persisting through modern design. See the introduction for more on this.

9 Benjamin, "The Work of Art," 113. Hermeneutics, as I note in the introduction, holds that the art object is fundamentally cloaked in a mystical veil of secrecy, a shell penetrated only by critique and interpretation.

10 Franke, *Computer Graphics*, 157; Franke, "A Cybernetic Approach to Aesthetics."

11 Heidegger, *Basic Writings*, 172.

12 The similarities between Max Bense's and Friedrich Kittler's provocative styles, two generations apart, should not go unnoted. I would like to thank John Durham Peters for pointing this out.

13 Hörl, personal correspondence.

14 Heidegger, *Basic Writings*, 322.

15 Heidegger, *Basic Writings*, 322; Kittler, "Thinking Colours," 49.

16 Benjamin, "The Work of Art," 113.

17 Benjamin, *Illuminations*, 238.

18 Turner, "Romantic Automatism," 9.

19 See Wigley, "Network Fever."

20 Burnham, "Systems Esthetics."

21 See also Alloway, "Network" or the introduction to this book.

22 Frieder Nake, personal correspondence.

23 Goodman, *Languages of Art*, 114.

24 Goodman, *Languages of Art*, 192–93.

25 Fechner, *Elemente der Psychophysik*; de Heer, *The Architectonic Colour* 35.

26 Zeising, *Neue Lehre*; Padovan, *Proportion*, 306.

27 Henry, *Sensation et énergie* 1, 220. Also see Lalo, *Introduction à l'esthétique*.

28 As I discuss in chapter 1, the subjective view of color and perception, popularized by Goethe, Kant, and Rousseau, remained in fashion in nineteenth-century art and science and continues today, especially in phenomenology, light art, and, as I will show, in the "U.S." approach to computer art. In contrast, the so-called objective or "physical" approach to color, which I chart through Aristotle and Newton in chapter 1, is here adopted by the school of rational aesthetics and in Bense's project to "Program the Beautiful." At the same time, some degree of crossover must be acknowledged. For instance, Herbert Franke adopts the principles of rational aesthetics to analyze subjective responses, while the school of experimental aesthetics, to be sure, holds to objective and universal aesthetic ideals.

29 Birkhoff, *Aesthetic Measure*, 27.
30 Birkhoff, *Aesthetic Measure*, 28.
31 Pias, "Holerith's 'Feathered Crystal,'" 116.
32 Shannon and Weaver, *Mathematical*, 8.
33 Birkhoff, *Aesthetic Measure*, 28.
34 Birkhoff, *Aesthetic Measure*, 118.
35 Nake, "The Semiotics Engine."
36 Nake, "The Semiotics Engine."
37 Bense, cited in Nake, "The Semiotics Engine."
38 Nake, "The Semiotics Engine."
39 Nake, personal correspondence.
40 Nake, personal correspondence.
41 Pias, "Holerith's 'Feathered Crystal,'" 115.
42 Nake, personal correspondence.
43 Bense, cited in Pias, "Holerith's 'Feathered Crystal,'" 115.
44 Gunzenhäuser, *Die ästhetische Theorie G. D. Birkhoffs*; Pias, "Holerith's 'Feathered Crystal,'" 117.
45 Franke, *Computer Graphics*, 154.
46 There are of course exceptions including Marcel Duchamp, Gerhard Richter, and Bridget Riley, all of whom approach color as a code whether in a Pantone chart or mass-produced paint tube. For more examples see Temkin, *Color Charts*.
47 Nake, personal correspondence.
48 Dietrich, "Visual Intelligence," 161.
49 Nake, personal correspondence.
50 Nake, personal correspondence.
51 One may also view the development of software color palettes as a kind of notation system—an allographic system that uses visual simulation to index abstract values. In this way, the newer allographic systems of the interface have, once again, been subjected to a remystification of code.
52 For instance, see the early computer art of Loyd Q. Summer, William Latham, Vladimir Bonačić, or Leslie Mezei.
53 See Brown et al. *White Heat, Cold Logic*.
54 Rosen, *A Little-Known Story*, 35. The New Tendencies artists and theorists also included such pioneers as theorist Umberto Eco, Croatian Radoslav Putar, Almir Mavignier, and Croatian critic and co-founder Matko Meštrović who also wrote the introduction on Abraham Moles in the first edition of *Bit International*.
55 Rosen, *A Little-Known Story*, 9–10.
56 Molnar, cited in Leavitt, *Artist*, 35–36; Molnar, "Vera Molnar."
57 Mohr, cited in Leavitt, *Artist*, 94; Leavitt, *Artist*, 35–36.
58 When it came to color, however, as I show below, the American pioneers gravitated towards avant-garde forms of color expression, rich in utopic and psychedelic motifs.
59 In chapter 5, I note how similar formal and modernist motifs are central to 2.0 web design, though less for reasons of technical limitation than for reasons of style and professionalism.
60 Blotkamp in Blotkamp, et al., *P. Struycken*, 11.
61 Schenk in Blotkamp, et al., *P. Struycken*, 17.
62 Struycken, "In search of an order in the relationship between shape and colour," in Blotkamp, et al., *P. Struycken*, 17.
63 Kees Van Twist in *P. Struycken*, 7; Blotkamp, et al., *P. Struycken*, 12.
64 Dekkers, "MODULES: A Digital Studio," 43.
65 Jobse in Blotkamp et al., *P. Struycken*, 36.
66 Blotkamp, "Exercises in Clarification," 62.
67 Jobse, in Blotkamp, *P. Struycken*, 116.
68 Jobse, in Blotkamp, *P. Struycken* 114.
69 Kees Van Twist in Blotkamp, *P. Struycken*, 7; Blotkamp in *P. Struycken*, 12; Dekkers in Blotkamp, *P. Struycken*, 43–44 The PDP1, introduced in the early 1960s, was the first mainframe that used a keyboard rather than punch cards for input.
70 Schenk in Blotkamp, *P. Struycken*, 23.
71 Dietrich, "Visual Intelligence," 166; Struycken, cited in Leavitt, *Artist and Computer*, 31; Jobse, in Blotkamp, *P. Struycken*, 126.
72 Struycken in Jobse, "Colour, that Miracle," 38–39.
73 Struycken in Jobse, "Colour, that Miracle," 37.
74 Blotkamp in *P. Struycken*, 12.
75 Struycken in Jobse, "Colour, that Miracle," 29.
76 Jobse, "Colour, that Miracle," 29.
77 Jobse, "Colour, that Miracle," 29.
78 Blotkamp, "Exercises in Clarification," 61.
79 Nake, personal correspondence.
80 Whitney, *Digital Harmony*, 184.
81 Patterson, "From the Gun Controller."
82 Mindell, "Anti-Aircraft," 109; Morritz, "Digital Harmony,"
83 Youngblood, *Expanded Cinema*, 107, 208.
84 Whitney, *Digital Harmony*, 39.
85 Whitney, *Digital Harmony*, 90–91.
86 Patterson, "From the Gun Controller."
87 Whitney, *Digital Harmony*, 6, 15, 30.
88 Whitney, *Digital Harmony*, 194.
89 Youngblood, *Expanded Cinema*, 215–18.
90 Whitney used this machine for effects on various Hollywood films, such as a sequence, produced with Saul Bass, for Alfred Hitchcock's *Vertigo* (1960).
91 Youngblood, *Expanded Cinema*, 107.
92 Whitney, *Digital Harmony*, 8, 113.
93 Whitney, *Digital Harmony*, 6, 38–39.

94 Interestingly, because of their non-grid organization, contemporary scholar Sean Cubitt refers to these early vector-based screen technologies as an "expression of a freedom . . . [and] imagined . . . potential . . . which still lies unrealized in the storeroom of residual media." Sean Cubitt, "Current Screens," 34.
95 Weibel, *Light Art*, 211.
96 She used this method to produce *Polka Graph* (1952) and *Abstronic* (1952).
97 Weibel, *Light Art*, 211.
98 Youngblood, *Expanded Cinema*, 275.
99 Youngblood, *Expanded*, 239.
100 Knowlton also collaborated with VanDerBeek on "Man and His World," and *Poemfield No.* 7 was performed by John Cage. Reichardt, *Computer in Art*, 78.
101 Reichardt, *Computer in Art*, 78; Knowlton, "Computer Produced Films."
102 Knowlton, personal correspondence.
103 VanDerBeek, *Newsreel of Dreams*.
104 Another example of early computer art could be explored in the work of California pioneer Grace C. Hertlein, especially *The Field* (1970), programmed in FORTRAN and depicting long and narrow green, black, and yellow stems in a field.
105 Youngblood, *Expanded Cinema*, 208.
106 Electronic Arts Intermix, "Visibles: Stan VanDerBeek."
107 VanDerBeek, "Culture: Intercom," 39.

Chapter 4

1 Levy, *Insanely*, 54.
2 Sutherland in Frenkel, "Interview," 712.
3 In a bitmap image every single pixel is "mapped" into a specific location on a raster grid so it appears on screen in a specific (nonlinear) order as the electron beam traces over it in a left-to-right scan order. The intensity of the raster scan beam is modulated according to a frame buffer, discussed later in this chapter.
4 Sutherland, "Sketchpad," 22.
5 Nelson, *Home Computer Revolution*; Meyers, "Brief History," 46.
6 Certainly kinds of basic programming (software) and hardware would come pre-assembled on the computers, as it was with the ENIAC (see the introduction), but this was only a very basic level that still needed systems and programs built on top of it in order for the machines to be used in particular ways.
7 Schwartz, *Handbook*, 4–5, 10.
8 Schwartz, *Lil*, chapter 5, 15–16.
9 Schwartz, *Lil*, chapter 5, 17–18.
10 Schwartz, *Lil*, chapter 5, 17–18.
11 Schwartz, *Lil*, chapter 5, 17–22.
12 Schwartz, *Lil*, chapter 5, 20–21.
13 Schwartz, *Lil*, chapter 5, 1.
14 Youngblood, *Expanded Cinema*, 246.
15 Knowlton, "Computer Technique,"; Knowlton, personal correspondence; Carlson, "CGI Historical Timeline." BEFLIX was also used to produce the VanDerBeek and Knowlton *Poemfields* computer films discussed in chapter 3 and was later used as the base for building TARPS, a two-dimensional alphanumeric processing language.
16 Reichardt, *Computer in Art*, 77; Knowlton, personal correspondence; Youngblood, *Expanded Cinema*, 246.
17 Schwartz, *Lil*, chapter 5, 1.
18 Experiments in Art and Technology, "Experiments in Art and Technology," 7; Biorn, "Mr. Biorn's Description of *Proxima Centauri*"; Schwartz, "I Remember MoMA."
19 Biorn, "Mr. Biorn's Description"; Schwartz, "Description of *Proxima Centauri*" and "Mechanical to Electronic Computer"; Coffey, "In the Mind of."
20 The piece is located in the Lillian Feldman Schwartz archives.
21 Schwartz, *Lil*, chapter 5, 4.
22 AT&T, "A Brief History: The Bell System."
23 Mervin was president from 1951 to 1959, James B. Fisk from 1959 to 1973, and William O. Baker from 1973 to 1979. Gertner, *The Idea Factory*, 3.
24 Mathews in Kurcewicz, "Lillian Schwartz."
25 Spiegel, interview; Kurcewicz, "Lillian Schwartz."
26 Spiegel, interview; Kurcewicz, "Lillian Schwartz."
27 Knowlton, "Portrait of the Artist," 8.
28 Hultén and Königsberg, *9 Evenings*; Turner, "Romantic," 19; Goodyear, "The Relationship of Art," 182.
29 Noll, interview.
30 Noll, "The Beginnings of Computer Art," 41.
31 Noll, interview. At the same time, Margit Rosen suggests there is no known date or "birth year" for the origin of computer art, as there is for photography or cinema ("however fictitious such dates may be"). This is likely true, given Ben Laposky's *Oscillons* from the late 1950s and early 1960s, discussed in the last chapter, and, as Rosen points out, German artist Kurd Alsleben and physicist Cord Passow's four plotter drawings

made using an analog computer at the German Electron-Synchotron research center in Hamburg in 1960. Both examples throw the already contentious notion of an origin date into further question. Rosen, *A Little-Known Story*, 9.

32 In many ways art history continues to reject the validity of digital art.

33 Knowlton, “Portrait of the Artist,” 10.

34 Knowlton, “Portrait of the Artist,” 11.

35 Spiegel, interview.

36 The origins of synthetic sound and electronic computer music may be further explored through such figures as Edgard Varèse, Léon Theremin, Robert Moog, Homer Dudley, Harald Bode, and Harry F. Olson.

37 Holmes, “Digital Synthesis”; Roads, “Interview with Max Mathews”

38 Kiritani, Miyawaki, Fujimura, and Miller, “Computational Model of the tongue,” S3.

39 Schwartz, *Handbook*, 152, 166; Rush, *New Media*, 176–77; Spalter, *The Computer*, 22.

40 These works are available for viewing on YouTube. Also see McCauley, *Computers and Creativity*, 87; Lehmann, “Moceptions”; and The City University of New York’s “Third International Computer Art Festival” detailed program guide, 4, 6.

41 Schwartz, *Handbook*, 136.

42 Vogel in Schwartz, *Lil*, chapter 6, 5, p. 8; Digital Art Museum, “Lillian Schwartz.”

43 Schwartz, *Handbook*, 114.

44 Schwartz, *Handbook*, 115.

45 The Whitney Museum of American Art, New American Filmmakers Series, cited in Schwartz, *Lil*, chapter 6, 8.

46 Geiger, *Chapel of Extreme*.

47 Moore, “Television,” 61–63.

48 Nietzsche, *Nietzsche contra Wagner*, 104.

49 See Geiger, *Chapel of Extreme*.

50 Lehmann, “Moceptions,” 6.

51 Vogel, cited in Schwartz, *Lil*, chapter 6, 7–9.

52 This does not refer to the stroboscopic animations, which remain challenging for viewers to watch. I thank Mimi White at Northwestern University for pointing this out.

53 Schwartz, *Handbook*, 115.

54 Lehmann, “Moceptions,” 6.

55 Schwartz, *Handbook*, 116.

56 Schwartz “Selected Art Films & Documentaries.”

57 Schwartz, *Handbook*, 116.

58 Schwartz, *Handbook*, 114, 116.

59 Gowing, *Critical Writings*, 55.

60 This was likely done using an optical bench and animation stand, as used in some of the other computer films. Schwartz, *Handbook*, 114, 120, 153; Schwartz, *Lil*, chapter 6, 4.

61 Schwartz, “Description of Computer Films.”

62 Schwartz, “Motion Picture / Computer”

63 Shoup, “Color Table,” 9.

64 Shoup, “SuperPaint,” 32.

65 For instance see Campbell-Kelly et al., *Computer: A History of the Information Machine*.

66 Another early frame buffer system was also developed at the University of Utah in the early 1970s. Smith, “Digital Paint Systems,” 6. Richard Shoup attributes the creation of this device to Noll as well. Shoup, “SuperPaint,” 37.

67 Smith, “Tint Fill,” 13.

68 Shoup, “Color Table,” 8, 12. Noll also suggests that he, Jack MacClean, and Denes collaboratively built a color frame buffer around 1969.

69 Kajiya, Sutherland, and Cheadle, “Random Access,” 1; Shoup, “Color Table,” 12. Shoup also notes the work of Andrew Lippman of the MIT Architecture Machine Group and M. Faust at Stanford University’s Artificial Intelligence Laboratory.

70 Shoup, “SuperPaint,” 32–34.

71 Shoup, “SuperPaint,” 32; Shoup, “Color Table,” 11–12.

72 “Real time” refers to a system with no lag time. However, as I indicated in note 53 in chapter 2, it has been argued that no digital system is truly real time because transcoding always introduces a lag of some sort. At the same time, relative to photographic chemical processing, all digital media is arguably real time.

73 Shoup, “SuperPaint,” 35–36.

74 Shoup, “Color Table,” 9.

75 Many other similar systems were produced during these years. In this chapter I have selected only the most relevant devices to expand on within the context of Bell Labs.

76 Shoup and Rarey went on to found Aurora Systems, now known as Multimedia Gulch, in 1980; in 1998, Shoup and Tom Porter received a technical Academy Award from the for “pioneering inventions in Digital Paint Systems.” Smith, “Technical Academy Award.”

77 Of course many scientists and researchers continue to work collaboratively. My point is that with digital color aesthetic techniques have largely become automated, proprietary (so too in science), and individualistic.

78 Spiegel, interview; Knowlton, interview.
79 Noll, "Man-Machine Tactile Communication," 5; Max Mathews, quoted in Kurcewicz, "Lillian Schwartz."
80 Kurcewicz, "Lillian Schwartz"; Noll, "Real-Time Interactive Stereoscopy," 14; Noll, interview.
81 Denes, "Computer Graphics in Color."
82 Schwartz, *Handbook*, 128.
83 Schwartz, *Handbook*, 128.
84 Knowlton, "EXPLOR"; Dietrich, "Visual Intelligence," 164–68; Schwartz, *Handbook*, 151–52, 166.
85 Schwartz, *Handbook*, 128, 152, Knowlton, interview; Knowlton, personal communication.
86 Knowlton, interview.
87 Schwartz, *Handbook*, 133.
88 Schwartz, *Handbook*, 128, 135.
89 Schwartz, *Handbook*, 133, 157.
90 Whitney, cited in Youngblood, *Expanded Cinema*, 217.
91 Knowlton, interview.
92 Beck, "Videographics," 21.
93 http://retiary.org/ls/btl/ls_btl_art.html.
94 Spiegel, personal correspondence
95 Spiegel, interview.
96 Spiegel, interview; Mathews and Moore, "GROOVE"; Roads, "Interview with Max Mathews."
97 Spiegel, personal correspondence.
98 Spiegel, personal correspondence.
99 Spiegel, interview.
100 Knowlton, personal correspondence.
101 The labs have since acknowledged a number of these achievements in early computer art.
102 Turkle, *The Second Self*, 9.
103 Schwartz, *Handbook*, 129.
104 To a red-green colorblind person certain reds or greens, or both, appear the same, or as a kind of brown.
105 I thank John Durham Peters for pointing this out.
106 Lillian Schwartz, "Notebooks."

Chapter 5

1 Stocks, "Destroy the Web 2.0 Look."
2 Lialina, "Vernacular Web 2."
3 Lialina, "Digital Folklore"; Lialina, "Vernacular Web 2."
4 Sterling, "Data Mine," 492.
5 When Jon Cates coined this last term in 2005, he did so in order to "express a contrast with the . . . cleanliness . . . [of] commercial or corporate styles of Digital Art and Design . . . The graphic and industrial design styles of Apple Computers is a perfect example of the kind of clean, smooth, slick style I am referring to." Cates, "ḅʀϬĶ3n ШR3▯▯▯ƠŖđẓ."
6 Kittler, *Optical Media*, 222.
7 Another fascinating analysis of the clean-cut 2.0 look versus a "dirtier" web style, as found in Facebook versus My Space, respectively, can be found in dana boyd's "Viewing American class divisions through Facebook and MySpace."
8 Earlier precursors may also be drawn from still photography and photomontage for instance, nineteenth-century practices in photomontage (from Hippolyte Bayard and Henry Van der Weyde) through Dada and Cubist collage and photomontage. I thank Ricardo Miranda for his expertise in this history.
9 In cinema, the racist undertones of this logic are discussed in Richard Dyer's *White: Essays on Race and Culture*, and illustrated in the figure of the "china girl." In early color television, the equally racist equivalent were "Kodak Shirley cards," used to calibrate white skin tone.
10 Barzyk, interview; Billups, "Key Thoughts."
11 Engelbart, "Research Center"; Engelbart, "Workstation History," 73–75.
12 Meyers, "Brief History," 45; Goldberg, *A History of Personal Workstations*
13 Meyers, "Brief History," 45–47; Goldberg, *A History of Personal Workstations*.
14 Friedberg, *Virtual Window*, 198. Other examples include *Pillow Talk* (1959), *The Thousand Eyes of Dr. Mabuse* (1960), *Rear Window* (1954), *Secret beyond the Door* (1948), and *Woman in the Window* (1944).
15 Fielding, *Technique*, 60.
16 Zielinski and Virilio, "Zbigniew Rybczyński," 199.
17 Rybczyński in Penz and Thomas, *Symposium on Cinema and Architecture*, 183; Zielinski and Virilio, "Zbigniew Rybczyński," 196.
18 Rybczyński in Penz and Thomas, *Symposium on Cinema and Architecture* 183; Zielinski and Virilio, "Zbigniew Rybczyński," 197.
19 Penz and Thomas, *Symposium on Cinema and Architecture* 189.
20 Manovich, *Language*, 141.
21 Carter, "Aesthetics, Video Art," 293.
22 Nake, personal correspondence (for further discussion see chapter 3).
23 Campus, interview.
24 Campus, interview.
25 Barzyk, interview.
26 Krauss, "Video: The Aesthetics of Narcissism," 52.

27 In *Understanding Media* (1964) Marshall McLuhan suggests a similar theory in regards to television.
28 Krauss, "Video," 52.
29 Krauss, "Video," 62.
30 Friedman, "Eight Artists," 23; Lorber, "Epistemological TV," 132.
31 Krauss, "Video," 59.
32 Hanhardt and Villaseñor, "Video / Media Culture," 22.
33 Barzyk, interview.
34 Barzyk, interview.
35 Wiener, *Cybernetics*.
36 Ryan, "Self-Processing," 32, 35. For more on cybernetic subjectivity see Kane, "The Tragedy of Radical Subjectivity."
37 Hayles, "Cybernetics," 149, 154.
38 Ryan in Scott, Wasiuta, and Ryan, "Cybernetic Guerrilla Warfare," 126.
39 Dickel, Osswald, and Zippay, in Campus, Herzogenrath, and Nierhoff, *Peter Campus*, 23, 77.
40 Hayles, "Hyper and Deep."
41 Stiegler, "Relational Ecology," 4, 13.
42 Merleau-Ponty, *Phenomenology*, 250.
43 At the same time, Stiegler remains critical of the concept because it does not consider the part that technical individuation plays within psychic and collective individuation.
44 Stiegler, "Relational Ecology," 3.
45 Stiegler, "The Theater of Individuation," 47–48; my italics.
46 Deleuze, *Negotiations*; Critchley, *Infinitely Demanding*, 44; Critchley, "Democracy and Disappointment."
47 Flusser, *Into the Universe*, 104.
48 Smith and Blinn, "A Pixel," 6.
49 Shoup, "Color Table," 8.
50 Smith and Blinn, "Alpha," 5–6.
51 For example, for a red pixel appearing at 50% opacity, the RGBA values would be expressed as 0.5, 0.0, 0.0, 0.5. It is also important to note that almost all raster image formats support the alpha channel.
52 In 1984, according to Wayne Carlson, Loren Carpenter also produced an alpha channel for frame buffers. Carlson, "Hardware Advancements."
53 Smith and Blinn, "Blue Screen Matting," 3.
54 Duff and Porter, "Compositing Digital Images," 254; Smith, "Image Compositing Fundamentals."
55 In electronic media an "image" is really only ever a dynamic and fluctuating series of composites and components arbitrarily caught in time.
56 Smith, "Digital Paint System," 3.
57 Smith and Blinn, "A Pixel," 5.
58 Manovich, "After Effects."
59 Manovich, "After Effects."
60 O'Reilly, "What Is Web 2.0."
61 Liu, *Laws*, 76–78.
62 Liu in Liu and Lovink, "Cool: Knowledge Work"; Liu, *Laws*, 75–80.
63 Bloch, *Utopian Function*, 80.
64 Liu in Liu and Lovink, "Cool: Knowledge Work"; Liu, *Laws,* 76–78.
65 See Manovich, *Language*, chapter 1. One may argue that dirt style and glitch aesthetics have since become homogeneous and flat, and this may be so, however, my concerns here are with the ways in which artists first employed these digital techniques and styles in critical and unique ways to challenge norms and expectations about perception and media consumption.
66 Cornell, "Welcome."
67 Ed Halter, "Invocations."
68 Fateman, "Totally Rad"; Cotter, "Doing Their Own"; Tarnoff, "Interview," 35; Huston, "Video Mutants."
69 Cornell, "Welcome."
70 This can be found at http://www.paperrad.org/oldindex2009.html (accessed May 26, 2013).
71 Paper Rad, "Problem Solvers."
72 Ciocci in Bieri, "Jam Pack."
73 Jacob Ciocci in Huston, "Video Mutants."
74 Halter, "Eleven Evocations."
75 Jacob Ciocci in "Video Mutants."
76 Halter, "Eleven Evocations."
77 Liu, *Laws,* 76–78, 179.
78 Stafford, "Lying Side by Side," 28.

Chapter 6

1 Foucault, *Discipline and Punish*, 195–228.
2 Deleuze, "Postscript on Control Societies," 177–82.
3 Agre, "Surveillance and Capture," 741–43.
4 Agre, "Surveillance and Capture," 740.
5 Galloway, "What You See is What You Get?," 166, 167.
6 Crary, *Suspensions of Perception*, 3.
7 Jay, *Downcast Eyes*.
8 Heidegger, "The Age of the World Picture," in *Question Concerning*, 129–30; my italics.
9 I wish to thank Martin Wallen for his insight and inquiry on this point.
10 Williams, *Marxism and Literature*, 121.
11 Granted there are different kinds of algorithms and it is impossible to define or locate a single algorithm in any digital application, my use of

the term is, as I note above, meant to connote a general logic of optic and visual indeterminability intrinsic to the information age.

12 Gillespie, "The Relevance of Algorithms."

13 But note that while algorithms perform this labor, humans conspire with micro-labor tasks like selecting "likes," shopping online, doing online research for certain topics, etc. Galloway, "The Poverty of Philosophy," 358.

14 Gillespie, "The Relevance of Algorithms."

15 Rancière, *The Politics of Aesthetics*, 85.

16 A nanometer is a billionth of a meter while 1 millimeter is equal to 30 THz (10 μm), so that far infrared dips into the microwave portion of the electromagnetic spectrum.

17 For more on "transcoding" see Manovich, *Language*.

18 Night Vision and Electronic Sensor Directorate, "Night Vision," 26. *Hept*, *Infrared Systems*, 16.

19 Also in the same year, the company sponsored the MoMA's popular Op Art exhibition, *The Responsive Eye* (Op Art is discussed in chapter 4).

20 Agre, "Surveillance and Capture," 741.

21 McCreary, "Gaining the Economic and Security Advantage."

22 Manovich, "What is Visualization."

23 Agre, "Surveillance and Capture," 746.

24 Other films that use infrared to touch on the limits of natural or human vision include *2001: A Space Odyssey* (1968), *Silence of the Lambs* (1991), *Blade Runner* (1983), *Terminator* (1984), *Navy Seals* (1990), *Cliffhanger* (1993), *Jurassic Park* (1993), *Ransom* (1996), *Black Hawk Down* (2001), *Phone Booth* (2003), *War of the Worlds* (2005), *Stealth* (2005), *Mr. and Mrs. Smith* (2005), *The Contract* (2006), *Patriot Games* (1992), *War / Rogue* (2007), and *Wargames: The Dead Code* (2008). And to note only a few artworks, there is Pulsa's 1969 infrared-lamp installation, Robert Rauschenberg's *Open Score* (1966), Timm Ulrichs' *Hidden Exhibition II* (1996), Simon Penny's *«Traces» Vision System* (1998), Steve Reinke's *Amsterdam Camera Vacation* (2001), and Chris O'Shea's *Out of Bounds* (2007).

25 Coker, "Defense Technology," 81.

26 Stiegler, *Technics and Time 2*, 2.

27 McEvilley, "Dennis Oppenheim at Ace," 132.

28 Sauter and Lüsebrink, "Zerseher."

29 Virilio, *Open Sky*, 93.

30 As I noted in chapter 1 and the introduction, *color of any kind is always a matter of technics*. One could then argue that chemical color exists as a chemistry formula before being produced as a pigment to be used in a painting or a strip of film. This is of course true; however, this chemical base has remained relatively benign and separate from artistic uses. With digital media, in contrast, increased technologization and informatization force color into a dramatically new mode of technical being that cannot be denied in our understanding of what digital color is (a transcoded and simulated phenomenon) and how it can be used new media aesthetics.

31 Alternatively, a monochrome infrared image would resemble a low-resolution "night vision" image's greenish-blacks.

32 Agre, "Surveillance and Capture," 745.

33 Krauss, "Frame by Frame," 416.

34 Tom Gunning has argued that this distinction is a false one because analog imaging practices also sample from the empirical world and then translate this data into another register. However, these analog imaging practices, such as photography or film, do *not* sample data to then *radically abstract* from it (or transcode it) into an *entirely different register*, completely uncontingent and only symbolically linked to its source, as is the case with digital imaging, and what I will in a moment equate with "technical images," by way of Vilém Flusser. Moreover, for Charles Pierce, whom Krauss, Mary Ann Doanne, and myself here follow, the symbolic versus the indexical is the very root of the distinction between these image types (the iconic being the third).

35 Flusser, *Into the Universe*, 6, 10.

36 Flusser, *Into the Universe*, 35.

37 See Kane, Review.

38 Flusser, *Into the Universe*, 44, 47–49. Flusser, *Into the Universe*, 102.

39 Flusser, *Into the Universe*, 44, 47–49. Flusser, *Into the Universe*, 102.

40 Media Art Net, "Robert Rauschenberg;" Loewen, "Experiments in Art," 75–88; Goodyear, "Relationship of Art" 195–203; Turner, "Romantic," 16.

41 Loewen, "Experiments in Art," 200; Turner, "Romantic," 7–8, 16.

42 Benjamin, *Illuminations*, 242; Breton, cited in Sontag, *Regarding the Pain of Others*, 23.

43 Haraway, *Simians, Cyborgs, and Women*, 164.

44 Crandall, "Heatseeking,"; Crandall and Holmes, "Immersion and 'Seeing Back,'" 222–27.

45 Armitage and Crandall, "Envisioning the Homefront," 21.

46 Crandall, *Drive*.

47 Weibel, “Jordan Crandall,” 7.
48 I wish to thank Linda Austen for her insight and inquiry on this point.
49 Deleuze, *Nietzsche and Philosophy*, 163.
50 Chow, *The Age of the World Target*.

Chapter 7

1 McLuhan, *Understanding Media*, 26.
2 Levin, “After Death,” E.1.
3 Riley, “Palettes,” 138.
4 Other examples that must be analyzed elsewhere include the work Takeshi Murata, Mark Amerika, and Daniel Temkin
5 Belton, “Painting,” 58.
6 Blake, “Angel Dust.”
7 Valdez, “Attack of the Abstract,” 3; Kinz, personal correspondence.
8 Higgins, *Harnessing the Technicolor Rainbow*.
9 Gunning, “Colorful Metaphors”; For more on this see Yumibe, *Moving Color*.
10 Bordwell, “Intensified Continuity,” 24, 16.
11 Price, “Color, the Formless,” 22–35.
12 Belton, “Painting by the Numbers,” 61.
13 Belton, “Painting by the Numbers,” 64.
14 Sitney, “*T,O,U,C,H,I,N,G*.”
15 Field, *“*Note.*”*
16 Serra, personal correspondence.
17 Throughout the history of Western thought, color has been aligned with madness, eroticism, childlike innocence—in contrast to the seriousness of line and form. For more on this see chapter 1.
18 Brakhage, “*Analytical Studies III*.”
19 For instance see the new media artwork discussed in the postscript or the work of C. B. Raes, Jason Salavon, Angela Bulloch, or Cory Arcangel.
20 Chang, “Jeremy Blake,” 17.
21 Kinz + Tillou Fine Art, “Bungalow 8.”
22 Kastner, “I can’t be / Satisfied.”
23 Blake, “Angel Dust.”
24 Kastner, “I can’t be / Satisfied.”
25 Kinz, personal correspondence.
26 Hayles, *How We Became Posthuman*, 36–37; my italics.
27 Flusser, *Post-History*, 56.
28 Flusser, *Post-History*, 56.
29 Tiedemann, “Dialectics at a Standstill,” 943.
30 Monk, *Spirit Hunter*, 19.
31 Manovich, *Language*, 135.
32 Manovich, “What Comes After Remix?”; Manovich, “After Effect”
33 Manovich, “After Effect.”
34 Levin, “After Death,” E.1.
35 Blake, “Sodium Fox.”
36 Hayles, *How We Became Posthuman*, 34.
37 It is in Blake’s work, however, that one finds a more dynamic deployment of digital color and nuanced negotiation between color and (narrative) form, and hence my detailed focus on his work throughout this chapter.
38 Manovich, “Generation Flash.”
39 Modernism is distinct from “modernity,” which suggests the process of modernization dating roughly to the year 1500. And while we still live with many of the “grand narratives” of modernism, we also embody many traits of the postmodern. Jameson, *Postmodernism*, 11.
40 Jameson, *Postmodernism*, 9
41 Jameson, *Cultural Turn*, 68.
42 While the work of Blake, Paper Rad, and others discussed in the last three chapters are all a part of the new paradigm of digital colorism, there are of course differences between them. For example, Paper Rad’s colors, as I note in chapter 5, tend to be more upbeat, at least initially, while Blake’s and Crandall’s are more cynical.
43 Jameson, *Postmodernism*, 34, 65.
44 McLuhan, *Understanding*, 22–23.
45 McLuhan, *Understanding*, 38–39.
46 Liu, *Laws*, 79.
47 Mumford, *Technics and Civilization*, 200.
48 Marx, *Capital*, vol. 1, 163.
49 Occupy or social media movements like “Twitter Revolutions,” sincere as they are, pale in comparison to the radical and progressive social and political ambitions and transformations of the 1960s and 1970s. For more on this see my forthcoming work on failure in compression aesthetics.

Postscript

1 Jones and Ryan, “Interview with Fecal Face.”
2 The other two current members include brother and sister Jacob and Jessica Ciocci.
3 Jones, *New Dark Age*.
4 Jones and Ryan, “Interview with Fecal Face.”
5 Hedgecoe and Tresidder, *Art of*, 25.
6 Pieribone, *Aglow in the Dark*, 125.
7 Clarke, “California Stands Firm on GloFish Ban.”
8 Zimmer, “Green Fluorescent Protein: Brainbow”; Livet in “Scientists Create Colorful ‘Brainbow’ Images.”
9 Lichtman in “Scientists Create Colorful ‘Brainbow’ Images.”

10 Pieribone, *Aglow in the Dark*, 223–25.
11 Abate, "Artist Proposes using Jellyfish"; Kac, "Bio Art"; Kac, *Telepresence and Bio Art*, 241; Kac, *Leonardo Electronic Almanac*.
12 Kac, *Telepresence and Bio Art*, 250.
13 Kac, *Telepresence and Bio Art*, 264, 286.
14 Deleuze, *Francis Bacon*, 71.
15 Jameson, *Postmodernism; Or, the Cultural Logic of Late Capitalism*, 65, 9.
16 Scott, *Architecture*, 248, 153.
17 Adorno, *Negative Dialectics*, 57.
18 Adorno, cited in Bloch, *The Utopian Function of Art and Literature*, 1.
19 Bloch, *Utopian Function*, 80.
20 See also Stiegler's *Technics and Time 1*.
21 Hays, "Music & Video Feedback / Video Light," 7.
22 Sandin, Wiseman, and Morton, "A Color Video Collaborative Process."
23 These younger new media colorists include Jennifer Steinkamp, C. B. Raes, Cory Arcangel, Jason Salavon, Angela Bulloch, Jeremy Blake (chapter 7), Paper Rad (chapter 5), Simon Payne, Takeshi Murata, Rafaël Rozendaal, Leo Villareal, and Sterling Ruby, to name only a few.
24 Steinkamp studied with both Gene Youngblood and computer graphics pioneer James Blinn.
25 Meyer and Shaked, *Jennifer Steinkamp*, 31.
26 Northrop, *Jennifer Steinkamp*.
27 Steinkamp, "Daisy Bell."

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